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# The Rate of Growth of the Wall-eyed Pike, *Stizostedion vitreum* (Mitchill), in Wisconsin's Inland Waters, with Special Reference to the Growth Characteristics of the Trout Lake Population[1]

By Clarence L. Schloemer and Ralph Lorch

## Introduction

JUDAY and Schloemer (1938), in a report on the growth of Wisconsin game fish, presented tables describing the age-length and length-weight relationship of the wall-eyed pike while Eddy and Carlander (1939) described the average growth rate of Minnesota specimens. In neither of these studies was an attempt made to distinguish between the growth rates of individual populations. Furthermore, with the exception of Deason's work, all growth studies previously made of this species have been based on age-actual length averages rather than on averages of calculated lengths made from past scale margins. The purpose of the present study is to describe the growth rates of fish comprising 39 Wisconsin populations of wall-eyed pike with special reference to the growth characteristics of the Trout Lake population. The growth data are all based on scale measurements and calculated lengths. All calculations were made with the assumption that the growth of the scale along its anterior radius and the growth of the body in length are in direct proportion. This assumption has been proven valid by the work of Deason still unpublished. Primary attention is given the Trout Lake population because of the greater number of specimens representing this group. Of the 1151 specimens included in the study 429 or 37.3 per cent were taken from Trout Lake. The outstanding limnological characteristics of Trout Lake are presented in Table I. The remaining 722 specimens represent 37 Wisconsin lakes and the Wisconsin River. All of these populations are represented by at least 5 specimens, with one-half of the lakes being represented by 10 or more and one-fifth by 25 or more. The authors realize that from a statistical standpoint a population represented by only 5 specimens may not adequately describe the general growth rate of fish in that population, but it was thought desirable to make use of all available data.

The length-weight relationship of the Trout Lake population is based entirely on data contributed by investigators at the Trout Lake Limnological Laboratory.[2]

[1] The majority of the data upon which these studies are based came from Wisconsin fishermen, who since 1928 have contributed scales and length-weight data from over 5,000 game fish taken from Wisconsin's inland lakes and streams. Needless to say, this cooperation between the fishing public and the fishery investigators at the University of Wisconsin and the Wisconsin Conservation Department is being continually encouraged and the value of this cooperation constantly emphasized. By this means the enthusiastic fishermen of the state can play an active part in Wisconsin's scientific attack on fishery problems, while, on the other hand, the fishery investigators derive valuable data with a minimum of expense and effort.

[2] The authors wish to acknowledge the assistance of the Wisconsin Conservation Department and the Works Progress Administration, from whom funds were obtained to carry on this study, and Professor C. Juday, whose interest in the work is reflected by the helpful suggestions he made and by his willingness to assist in any other way.

### Table I

Limnological Data for Trout Lake, Vilas County, Wisconsin. With the Exception of Hydrographical Details all Data Are Based on Average Surface Conditions During the Summer Months.*

| | North Basin | South Basin |
|---|---|---|
| Length in miles | 2.24 | 2.80 |
| Width in miles | 1.30 | 2.40 |
| Surface area in acres | 1,315 | 2,597 |
| Maximum depth in meters | 29.0 | 35.5 |
| Volume in 1,000 cubic meters | 69,017 | 149,020 |
| Secchi disc transparency in meters | 5.0 | 4.5 |
| Color platinum cobalt scale | 6.0 | 3.0 |
| pH | 7.8 | 7.6 |
| Conductivity in reciprocal meghoms | 73.0 | 77.0 |
| Bound $CO_2$ in milligrams per liter | 18.5 | 18.7 |
| Organic matter of plankton in milligrams per liter | 0.66 | 0.92 |

* Data furnished by the Wisconsin Geological and Natural History Survey.

## The Age and Growth Rate of the Trout Lake Population

The data on the growth rate of the Trout Lake population were first collected in 1927, at which time the United States Bureau of Fisheries and the Wisconsin Geological and Natural History Survey began cooperative investigations on the fisheries of the lakes in the northeastern highlands of the state. With the exception of 1929 each calendar year from 1927 to 1938, inclusive, is represented in the collection. The small number of specimens found in the early age groups were taken with gill nets. All the rest were caught with rod and reel.

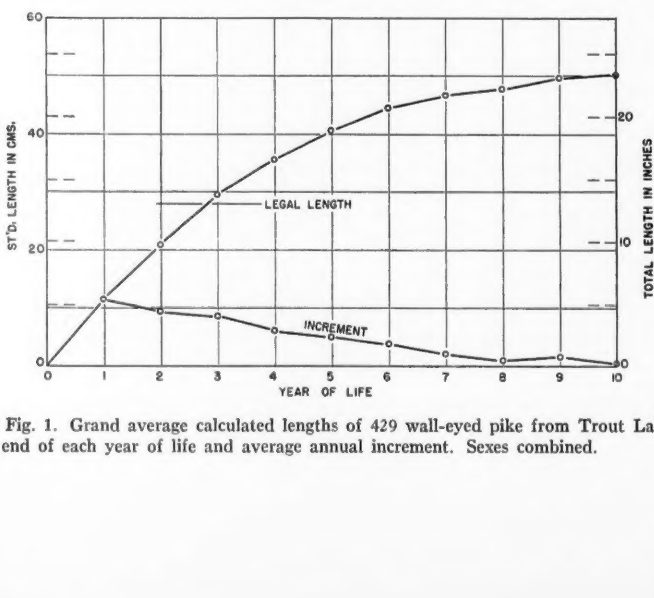


Fig. 1. Grand average calculated lengths of 429 wall-eyed pike from Trout Lake at the end of each year of life and average annual increment. Sexes combined.

Table II presents a frequency distribution of 432 Trout Lake specimens arranged according to age group and standard length intervals.

## Table II

Length-Frequency Distribution of 432 Wall-Eyed Pike from Trout Lake (Wisconsin) During the Years 1927–1938, Inclusive

| St'd. Length At 2.0 cm. intervals | Age Group | | | | | | | | | | | | Freq. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | |
| 8.0 – 9.9 | 2 | | | | | | | | | | | | 2 |
| 10.0 – 11.9 | | 1 | | | | | | | | | | | 1 |
| 12.0 – 13.9 | | 3 | | | | | | | | | | | 3 |
| 14.0 – 15.9 | | 7 | | | | | | | | | | | 7 |
| 16.0 – 17.9 | | 1 | 1 | | | | | | | | | | 2 |
| 18.0 – 19.9 | | 6 | 6 | | | | | | | | | | 12 |
| 20.0 – 21.9 | | 6 | 22 | 1 | | | | | | | | | 29 |
| 22.0 – 23.9 | | | 19 | 1 | | | | | | | | | 20 |
| 24.0 – 25.9 | | 1 | 12 | 5 | | | | | | | | | 18 |
| 26.0 – 27.9 | | | 6 | 1 | | | | | | | | | 7 |
| 28.0 – 29.9 | | | 4 | 5 | | | | | | | | | 9 |
| 30.0 – 31.9 | | | 1 | 9 | 1 | 2 | | | | | | | 13 |
| 32.0 – 33.9 | | | | 8 | 5 | | | | | | | | 13 |
| 34.0 – 35.9 | | | | 6 | 7 | 1 | 1 | | | | | | 15 |
| 36.0 – 37.9 | | | | 3 | 5 | 8 | – | 1 | | | | | 17 |
| 38.0 – 39.9 | | | | 2 | 5 | 7 | 2 | | | | | | 16 |
| 40.0 – 41.9 | | | | 3 | 6 | 10 | 8 | 3 | 2 | | | | 32 |
| 42.0 – 43.9 | | | | | 5 | 16 | 5 | 6 | 3 | | | | 35 |
| 44.0 – 45.9 | | | | 2 | 4 | 13 | 8 | 1 | 7 | | | | 35 |
| 46.0 – 47.9 | | | | | 2 | 3 | 4 | 10 | 5 | 4 | | 1 | 29 |
| 48.0 – 49.9 | | | | | 1 | 7 | 7 | 13 | 3 | 1 | | | 32 |
| 50.0 – 51.9 | | | | 1 | – | 2 | 5 | 6 | 6 | 5 | | | 25 |
| 52.0 – 53.9 | | | | | | 1 | 5 | 8 | 6 | 1 | | | 21 |
| 54.0 – 55.9 | | | | | | | 4 | 6 | 3 | 3 | 3 | | 19 |
| 56.0 – 57.9 | | | | | | 1 | 3 | 4 | – | 2 | | | 10 |
| 58.0 – 59.9 | | | | | | | 3 | 1 | 2 | | | | 6 |
| 60.0 – 61.9 | | | | | | | 1 | 1 | 1 | | | | 3 |
| 62.0 – 63.9 | | | | | | | | | 1 | | | | 1 |
| Freq. | 2 | 25 | 71 | 47 | 41 | 71 | 56 | 60 | 39 | 16 | 3 | 1 | 432 |

An analysis of this distribution shows that 37.7 per cent of the wall-eyed pike caught during the span of 11 years ranged from 40 to 50 cms. or from 15.7 to 19.7 inches. Of these individuals, 30 per cent belonged to age group V, while the remaining 70 per cent fell in age groups III to VIII. The legal length minimum of 13 inches (33.0 cms.), total length, or 10.96 inches (27.9 cms.), standard length, was attained by 5 of the 71 specimens belonging to age group II, by 39 of the 47 specimens belonging to age group III, and by all of the 41 specimens in age group IV.

On the basis of this frequency distribution, therefore, it can be concluded that the fastest growing members of this population attain the minimum legal length during their third season of growth, while 83 per cent of the individuals reach or exceed this length during their fourth summer of life. This conclusion is in fair agreement with that derived from the average growth curve of the population based on calculated lengths which indicates that the legal length minimum is attained by the average growing members of the population late during their third growing season.

The data in Table II also indicate that wall-eyed pike of similar age show considerable variation in growth rate. For example, specimens belonging to age group V ranged in standard length from 30.4 to 56.1 cms. or from 12 to 22 inches, with the modal length falling between 43.0 to 43.9 cms., or 17 inches. This variation in growth is also indicated by the range of ages falling within a given length range. For example, individuals measuring 40.0 to 41.9 cms. or approximately 16 inches in standard length were from 3 to 8 years of age. Such variation in growth is not unusually great in the early age groups, but in the older age groups, well represented by specimens, the spread is very apparent. The difference in length between the longest and the shortest specimens in age groups I and II, for example, amounts to less than 15 cms., whereas this difference for the older age groups (III to VIII) averages over 25 cms.

TABLE III

THE CALCULATED LENGTHS OF 429 TROUT LAKE WALL-EYED PIKE TAKEN DURING THE YEARS 1927–1938, INCLUSIVE; SEXES COMBINED

| Age Group | Freq. | Average Actual Length | Year of Life | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| XI | 1 | 46.0 | 6.5 | 15.9 | 22.2 | 30.3 | 34.1 | 36.2 | 37.8 | 38.5 | 42.0 | 43.8 | 45.0 |
| X | 4 | 53.0 | 8.7 | 16.0 | 23.3 | 30.7 | 36.6 | 41.5 | 44.8 | 47.5 | 49.7 | 51.6 | |
| IX | 15 | 51.4 | 9.8 | 18.3 | 26.9 | 32.2 | 37.4 | 42.0 | 45.3 | 47.9 | 50.0 | | |
| VIII | 40 | 49.2 | 10.4 | 19.6 | 28.2 | 34.4 | 39.1 | 43.0 | 45.6 | 47.9 | | | |
| VII | 60 | 50.7 | 11.5 | 21.2 | 28.8 | 36.2 | 41.3 | 45.1 | 47.9 | | | | |
| VI | 56 | 47.8 | 13.4 | 23.3 | 30.5 | 37.8 | 42.5 | 45.0 | | | | | |
| V | 71 | 42.8 | 11.1 | 20.5 | 29.1 | 35.1 | 40.2 | | | | | | |
| IV | 39 | 39.2 | 12.5 | 21.7 | 30.1 | 35.5 | | | | | | | |
| III | 45 | 33.2 | 12.4 | 21.4 | 29.7 | | | | | | | | |
| II | 71 | 23.0 | 9.8 | 19.3 | | | | | | | | | |
| I | 25 | 17.8 | 11.4 | | | | | | | | | | |
| 0 | 2 | 9.6 | | | | | | | | | | | |
| Average Standard Lengths in Cms. | | | 11.4 | 20.8 | 29.4 | 35.6 | 40.6 | 44.5 | 46.6 | 47.7 | 49.6 | 50.1 | 45.0 |
| Average Annual Increment in Cms. | | | 11.4 | 9.4 | 8.6 | 6.2 | 5.0 | 3.9 | 2.2 | 1.1 | 1.8 | 0.4 | .. |
| Average Total Length in Inches* | | | 5.3 | 9.7 | 13.7 | 16.6 | 19.0 | 20.7 | 21.7 | 22.3 | 23.1 | 23.3 | .. |
| Average Annual Increment in Inches | | | | 4.4 | 4.0 | 2.9 | 2.4 | 1.7 | 1.0 | 0.6 | 0.8 | 0.2 | .. |

* $\frac{\text{Total L.}}{\text{St'd. L.}} = 1.184$

These data show that the wall-eyed pike of Trout Lake reach a standard length of 11.4 cms. (5.3 in. T.L.) at the end of their first year of life; 20.8 cms. (9.7 in. T.L.) at the end of their second year and 29.4 cms. (13.7 in. T.L.) at the end of their third year. After the fourth year the annual increase in length falls off approximately one cm. each year until beyond the ninth year when the annual increment is less than one cm. The maximum age attained by any member of the population was eleven years.

The growth curve of the Trout Lake population based on averaged calculated lengths for each year of life, and the annual increments in length are presented graphically in Fig. 1. The data upon which these curves are based appear in Table III. Since many of the wall-eyed pike caught were not sexed the growth data of the sexes were combined.

### The Growth Data Rate of the Trout Lake Population Compared with that of Lake Erie

The growth rate of the Trout Lake population compared with that of Lake Erie, as reported by Deason (1933), shows that the Trout Lake specimens grow at a somewhat faster rate than the wall-eyed pike of Lake Erie during their early years of life. Using the Wisconsin legal length minimum as a basis for comparison we find that the Lake Erie fish require four summers to reach the length of 13 inches, whereas, the Trout Lake specimens attain this length late in their third summer of life. The relative differences between the growth rates of these two populations is better seen in Table IV. Only

### Table IV

A Comparison of the Growth Rates of Lake Erie and Trout Lake Wall-eyed Pike as Based on Calculated Lengths in Centimeters for the First 4 Years of Life

| Age group | Freq. | | Year of life | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1. | | 2. | | 3. | | 4. | |
| | E. | T. | E. | T. | E. | T. | E. | T. | E. | T. |
| I | 493 | 25 | 10.1 | 11.4 | | | | | | |
| II | 853 | 71 | 8.6 | 9.8 | 18.4 | 19.3 | | | | |
| III | 60 | 45 | 8.5 | 12.4 | 17.0 | 21.4 | 24.0 | 29.7 | | |
| IV | 19 | 39 | 9.0 | 12.5 | 18.7 | 21.7 | 26.3 | 30.1 | 32.2 | 35.5 |
| Average | | | 9.1 | 11.5 | 18.1 | 20.8 | 25.2 | 29.9 | 32.2 | 35.5 |
| Difference (T.—E.) | | | 2.4 | | 2.7 | | 4.7 | | 3.3 | |

the first four age groups are included in this comparison since very few individuals represent the higher age groups in the Lake Erie collection. At the end of the first year, the average difference in length between the two populations amounted to 2.4 cms., or approximately one inch; at the end of the second year this difference was 2.7 cms. At the end of the third year it increased to 4.7 cms. and at the end of the fourth year it amounted to 3.3 cms. Despite the better growth of the Trout Lake wall-eyed pike during these early years, however, there is some reason to believe that in the later years the Lake Erie fish grow at a faster rate than those from Trout Lake.

### The Length-Weight Relationship of the Trout Lake Population

The relationship between the length and weight of 266 wall-eyed pike from Trout Lake is presented in Table V. These specimens ranged in standard length from 12.8 to 63.8 cms. and in weight from 28 to 3,067 gms.

### Table V

The Length-Weight Relationship of 266 Trout Lake Wall-eyed Pike Expressed in Standard Length; Grams and Total Length; Pounds and Ounces

| St'd. Length at 2.5 cm. intervals | No. of Specimens | Av. weight in grams | Average wt. in pounds and ounces | | Total Length in inches |
|---|---|---|---|---|---|
| | | | lbs. | oz. | |
| 12.5–14.9 | 4 | 40 | | 1.4 | 5.8– 6.9 |
| 15.0–17.4 | 7 | 50 | | 1.8 | 7.0– 8.1 |
| 17.5–19.9 | 10 | 104 | | 3.7 | 8.2– 9.3 |
| 20.0–22.4 | 26 | 128 | | 4.5 | 9.3–10.4 |
| 22.5–24.9 | 17 | 170 | | 6.0 | 10.5–11.6 |
| 25.0–27.4 | 7 | 248 | | 8.7 | 11.7–12.8 |
| 27.5–29.9 | 11 | 331 | | 11.7 | 12.8–13.9 |
| 30.0–32.4 | 5 | 424 | | 14.9 | 14.0–15.1 |
| 32.5–34.9 | 6 | 529 | 1 | 2.6 | 15.1–16.3 |
| 35.0–37.4 | 9 | 712 | 1 | 9.2 | 16.3–17.4 |
| 37.5–39.9 | 13 | 914 | 2 | 0.2 | 17.5–18.6 |
| 40.0–42.4 | 24 | 1140 | 2 | 8.1 | 18.6–19.8 |
| 42.5–44.9 | 31 | 1245 | 2 | 11.8 | 19.8–20.9 |
| 45.0–47.4 | 30 | 1336 | 2 | 15.0 | 21.0–22.1 |
| 47.5–49.9 | 19 | 1414 | 3 | 1.8 | 22.1–23.3 |
| 50.0–52.4 | 18 | 1718 | 3 | 12.5 | 23.3–24.4 |
| 52.5–54.9 | 10 | 2205 | 3 | 13.6 | 24.5–25.6 |
| 55.0–57.4 | 13 | 2328 | 5 | 2.0 | 25.6–26.8 |
| 57.5–59.9 | 4 | 2594 | 5 | 11.0 | 26.8–27.9 |
| 60.0–62.4 | 1 | 2726 | 6 | .... | 28.0–29.1 |
| 62.5–64.9 | 1 | 3067 | 6 | 12.0 | 29.1–30.2 |

When expressed in terms of total length in inches and weight in pounds they ranged between 5.9 to 29.7 inches and between one ounce to 6.5 pounds. Standard length was converted to total length by use of the factor 1.184. No consideration was given to the possibility that the ratio between standard and total lengths might change slightly with increases in length in this species.

These length-weight data are presented graphically in Fig. 2. The slope of the curve indicates that up to the time the Trout Lake wall-eyed pike attain the length of approximately 28.0 cms. their growth in standard length exceeds their growth in weight, but beyond this length the reverse is true. Translated into terms of age the length-weight relationship shows that this population begins to grow more rapidly in weight than in length

### Table VI

The Variation of K, the Coefficient of Condition with the Age of the Trout Lake Wall-eyed Pike

| Age Group | No. of Specimens | K | Age Group | No. of Specimens | K |
|---|---|---|---|---|---|
| 0 | 1 | 1.4874 | VI | 51 | 1.4777 |
| I | 24 | 1.3771 | VII | 56 | 1.3504 |
| II | 51 | 1.3774 | VIII | 33 | 1.4261 |
| III | 43 | 1.4662 | IX | 16 | 1.3802 |
| IV | 30 | 1.6153 | X | 3 | 1.4638 |
| V | 66 | 1.5156 | XI | 1 | 1.5298 |

late during its third growing season. It is interesting to note that this change occurs at approximately the time the average growing members attain the minimum legal length. The average weight of the fish at this time is 0.67 of a pound.

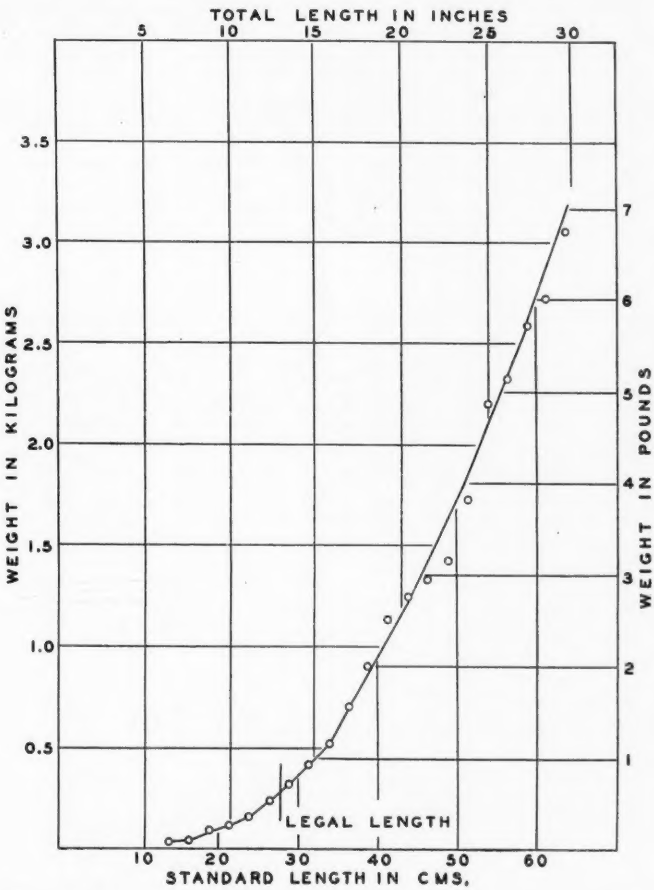


Fig. 2. Length-weight relationship of 266 wall-eyed pike from Trout Lake; sexes combined.

The average coefficient of condition or the "relative fatness" of the Trout Lake population was 1.4463. This coefficient was determined from the formula $K = \frac{W}{L^3} 10^2$, where

W is weight in grams, and L is standard length in centimeters.

## Table VII

The Average Calculated Lengths of Fish in 39 Wall-Eyed Pike Populations Taken from Wisconsin Waters Expressed in Centimeters; Sexes Combined
(25 or more specimens)

| Lake | County | Freq. | Year of Life | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Allequash... | Vilas | 33 | 9.0 | 19.5 | 27.6 | 33.8 | 39.4 | 42.3 | 45.0 | 46.7 | | | | |
| Bass....... | Dane | 52 | 17.5 | 28.8 | 36.6 | 42.0 | 46.0 | 52.3 | | | | | | |
| Big Bearskin | Oneida | 38 | 10.0 | 18.2 | 24.7 | 28.9 | 31.4 | 33.0 | | | | | | |
| Chippewa Flowage.. | Sawyer | 40 | 11.3 | 20.3 | 27.4 | 32.9 | 38.2 | 42.8 | 45.9 | 51.5 | 53.0 | | | |
| Clear....... | Oneida | 77 | 8.6 | 17.1 | 22.9 | 27.1 | 30.1 | 33.7 | | | | | | |
| Kegonsa | Dane | 95 | 14.2 | 22.0 | 32.6 | 36.2 | 36.4 | 37.3 | | | | | | |
| Mud (Little Star)..... | Vilas | 88 | 11.4 | 20.3 | 22.9 | | | | | | | | | |
| Trout...... | Vilas | 429 | 11.4 | 20.8 | 29.4 | 35.6 | 40.6 | 44.5 | 46.6 | 47.7 | 49.6 | 50.1 | 45.0 | |
| | | | 10 to 25 specimens | | | | | | | | | | | |
| Big........ | Vilas | 14 | 11.2 | 21.0 | 27.6 | 31.4 | 38.4 | 45.5 | 50.9 | 52.8 | 56.0 | 58.0 | | |
| Big Bass.... | Vilas | 17 | 10.5 | 19.0 | 25.2 | 31.9 | 36.0 | 40.4 | 44.0 | 43.4 | 46.8 | | | |
| High....... | Vilas | 11 | 13.0 | 23.5 | 33.2 | 37.8 | 40.5 | 44.1 | 47.4 | 51.8 | 57.6 | | | |
| Lost........ | Vilas | 21 | 9.4 | 17.6 | 22.5 | 28.5 | 30.3 | 34.6 | 43.7 | | | | | |
| Moose...... | Sawyer | 14 | 10.9 | 18.3 | 24.4 | 29.6 | 34.3 | 38.8 | 43.4 | 46.3 | 50.0 | 52.9 | 54.6 | 58.0 |
| Red Cedar.. | Barron | 18 | 11.2 | 19.2 | 25.6 | 30.4 | 33.7 | 36.8 | 39.2 | 40.2 | | | | |
| St. Croix.... | Douglas | 10 | 15.4 | 26.2 | 33.8 | 41.3 | 46.0 | 48.1 | 48.9 | | | | | |
| Teal........ | Ashland | 10 | 10.4 | 18.3 | 24.6 | 30.5 | 35.8 | 39.2 | 42.1 | | | | | |
| Tomahawk.. | Oneida | 16 | 13.3 | 20.7 | 27.1 | 32.5 | 37.8 | 40.9 | 42.5 | 46.2 | 48.2 | 48.6 | | |
| Wildcat..... | Vilas | 10 | 9.9 | 20.4 | 29.2 | 35.8 | 35.0 | | | | | | | |
| Wolf....... | Vilas...... | 24 | 11.7 | 19.8 | 26.1 | 30.0 | 32.7 | 35.2 | | | | | | |
| Wisconsin R. | | 19 | 13.7 | 23.6 | 30.4 | 36.3 | 41.4 | 46.8 | 54.6 | 62.1 | 57.3 | 68.0 | 70.0 | 74.0 |
| | | | 5 to 10 specimens | | | | | | | | | | | |
| Bear....... | Barron.... | 5 | 14.0 | 25.6 | 37.0 | 43.5 | 48.6 | 54.2 | 51.4 | 54.2 | 57.5 | | | |
| Big St. Germain.. | Vilas | 9 | 12.0 | 20.4 | 27.6 | 33.4 | 37.7 | 47.5 | 55.1 | 60.0 | 63.0 | 67.3 | | |
| Crooked.... | Vilas...... | 7 | 11.8 | 23.4 | 31.6 | 35.3 | 37.8 | 43.3 | 44.8 | | | | | |
| Fay........ | Florence | 5 | 13.7 | 26.5 | 33.5 | 40.7 | 44.7 | 49.1 | 51.6 | | | | | |
| Fence...... | Vilas | 6 | 10.7 | 16.5 | 25.3 | 32.0 | 37.5 | 40.1 | 42.1 | 45.6 | 47.6 | 50.5 | 52.8 | 53.6 |
| Helen...... | ...... | 6 | 10.8 | 26.1 | 35.4 | 40.7 | 46.0 | | | | | | | |
| Long....... | Vilas | 5 | 10.6 | 16.9 | 22.9 | 27.9 | 31.8 | 34.8 | 37.7 | 40.0 | | | | |
| Minocqua... | Oneida | 6 | 12.6 | 20.2 | 28.4 | 33.5 | 39.4 | 43.5 | 53.8 | 60.0 | | | | |
| Minnemac.. | Sawyer | 5 | 12.8 | 20.0 | 28.6 | 35.6 | 40.6 | 44.2 | 49.7 | | | | | |
| Noquebay... | Marinette | 9 | 11.3 | 18.3 | 24.2 | 28.6 | 32.9 | 35.9 | 36.9 | 38.7 | | | | |
| Pike | Polk | 5 | 11.9 | 20.7 | 28.6 | 35.6 | 42.2 | 41.9 | | | | | | |
| Poygan..... | Winnebago | 5 | 10.0 | 21.1 | 27.9 | 32.9 | 36.7 | 38.0 | 39.5 | | | | | |
| Prairie...... | Barron | 6 | 12.1 | 24.8 | 33.0 | 36.8 | 36.2 | 37.2 | | | | | | |
| Sand....... | Vilas | 7 | 12.2 | 22.2 | 27.1 | 35.9 | 45.8 | 52.6 | 64.6 | 65.1 | | | | |
| Silver...... | Vilas | 6 | 10.8 | 18.7 | 27.6 | 32.5 | 27.2 | | | | | | | |
| Spring...... | ...... | 7 | 11.5 | 24.9 | 34.8 | 39.2 | | | | | | | | |
| Slim........ | ...... | 6 | 9.6 | 18.8 | 24.4 | 30.1 | 35.2 | 39.2 | 47.7 | | | | | |
| Star........ | Bayfield | 5 | 14.0 | 22.4 | 23.7 | | | | | | | | | |
| Stone....... | Oneida | 5 | 11.0 | 19.8 | 27.9 | 31.4 | 36.0 | 41.7 | 47.7 | 50.4 | | | | |
| Unweighted standard length average in centimeters....... | | | 11.7 | 21.1 | 28.3 | 34.0 | 38.1 | 41.8 | 46.8 | 49.9 | 53.2 | 56.0 | 55.6 | 61.9 |
| Unweighted total length average in inches........... | | | 5.4 | 9.8 | 13.2 | 15.9 | 17.8 | 19.5 | 21.8 | 23.3 | 24.8 | 26.1 | 25.9 | 28.9 |

The average calculated growth rate of each population is presented in Table VII. The Bass Lake population located in Dane County showed a faster growth rate than any other population studied. At the end of the first year of life the average standard length of 52 individuals was 17.5 cms. At the end of the second year they averaged 28.8 cms.; and at the end of the sixth growing season 3 members of this population averaged 52.3

cms. in standard length. The slowest growth was made by the 77 specimens from Clear Lake in Oneida County. At the end of their first growing season the average standard length of these wall-eyed pike was only 8.6 cms. At the end of the second growing season their average length had increased to 17.1 cms., while at the end of the sixth growing season 11 members of this population averaged only 33.7 cms. Expressed in terms of total length in inches these Clear Lake wall-eyed pike required six years of growth to reach a length of 15.5 inches, whereas, the Bass Lake specimens averaged 24.4 inches in this time, a difference of nearly 9 inches.

All of the other populations fell between these extremes with respect to their average growth rates. The average calculated lengths of all the 39 populations show that Wisconsin wall-eyed pike are 11.7 cms. long at the end of their first year of life and at the end of their second growth season they have attained a length of 21.1 cms. Upon the completion of the third year their average length is 28.3 cms. and from that age on until the end of their twelfth growing season they increase at a rate of 2.2 to 5 cms. each year. The 3 oldest specimens were twelve years of age and averaged 61.9 cms. in standard length. The total length equivalents appear in Table VII.

It was found that this coefficient varied with the age of the fish. Wall-eyed pike belonging to age group IV were in the best relative condition, while members of this population belonging to the lower age groups had lower condition factors, but tended to better their condition with increase in age. In the fish of the higher age groups the condition factor was lower than that found in age group IV. No explanation is attempted to account for this apparent decrease in condition beyond this age. These data are presented in Table VI.

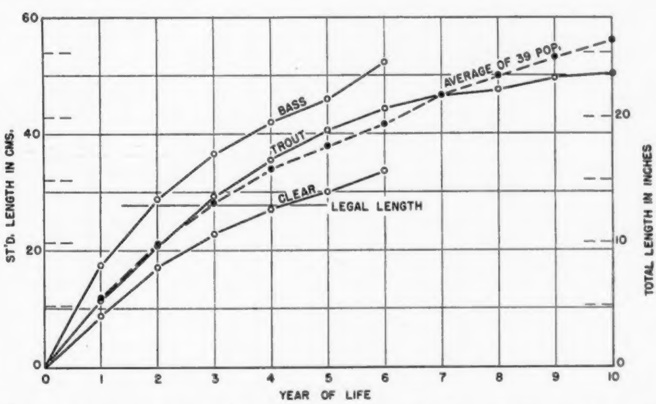


Fig. 3. Comparative growth curves of 3 Wisconsin wall-eyed pike populations based on average calculated lengths at the end of each year of life; the average growth rate of 39 Wisconsin wall-eyed pike populations and the average time the legal length minimum for the state is attained.

## Comparative Growth of the Wall-eyed Pike in Wisconsin's Inland Waters

The comparative growth rates of the Bass, Trout and Clear lake populations and the average growth rate of all the populations are presented in

Figure 3. It is interesting to note that the growth rate of the Trout Lake population approximates fairly closely the average rate of growth made by the other populations.

TABLE VIII

THE SUMMERS OF LIFE REQUIRED BY 37 WISCONSIN WALL-EYED PIKE POPULATIONS TO ATTAIN THE LEGAL LENGTH MINIMUM OF 13 INCHES, TOTAL LENGTH

| | Age in summers | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Per cent which attained the legal length minimum......... | 0.0 | 2.7 | 48.6 | 97.3 | 100.0 |

Only the Bass Lake fish reached the legal length minimum of 13 inches in "over all" length during their second growing season. Of the 37 populations, however, 18 grew sufficiently fast to attain this length during the third year of life while 36 of the 37 populations studied had attained this length by the time the fourth annulus had appeared on their scales. Only one population, that of Clear Lake, required five seasons of growth before becoming legal in length. Expressed in terms of per cent, 48.6 per cent of the 37 populations had reached a length of 13 inches in total length during their third growing season, whereas, 97.3 per cent had attained this length during their fourth summer of life. It should be remembered, however, that this conclusion is based on the average growth rate of each population. Individual members of this species may require as long as eight years before first reaching legal size. (Juday and Schloemer, 1938).

A summary of the ages at which the legal length minimum is attained by wall-eyed pike in these waters is given in Table VIII. Only 37 of the populations were included in this analysis since none of the pike taken from Mud (Little Star) and Star lakes were of legal size when captured, having been taken by investigators using fine meshed gear.

## SUMMARY

1. This study is based on scale envelope data and calculated lengths from the scales of 1151 wall-eyed pike from 38 Wisconsin lakes and the Wisconsin River.

2. The Trout Lake population located in Vilas County, represented by 37.3 per cent of the entire collection, is given special attention.

3. Trout Lake wall-eyed pike grow at an extremely variable rate. Individuals approximately 16 inches in standard length ranged from three to eight years of age, while specimens five years of age ranged from 12 to 22 inches in length.

4. The Wisconsin legal length minimum of 13 inches in total length is reached by Trout Lake wall-eyed pike during their third summer of life. Compared with a Lake Erie population studied previously, the Trout Lake population grows at a somewhat faster rate, at least during the first four years.

5. The length-weight relationship of the Trout Lake population shows that Trout Lake wall-eyed pike average 0.67 pounds when they first attain the legal length minimum. The range in total length for all the specimens

included in the computations was from 5.9 to 29.7 inches and from 1 ounce to 6.5 pounds in weight.

6. The coefficient of condition for the Trout Lake population averaged 1.4463. This coefficient tended to vary with the age of the fish.

7. A comparative growth study of this species in Wisconsin waters showed the fastest growing population reached 13 inches in total length during its second growing season, while the slowest growing population required five summers of growth to reach this length.

8. Based on their average growth rates nearly 50 per cent of the 39 populations studied grew fast enough to become legal in size during their third growing season, while 97 per cent accomplished this during the fourth summer of life.

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North Texas State Teachers College, Denton, Texas.

# On the Phenomenon of Locomotor Disorganization Induced by Strong Light in Small Plectognath Fishes

By C. M. Breder, Jr.

A CURIOUS item of behavior reported by Breder (1929), Harris (1934) and Breder and Harris (1934 and 1935) was the induction of violent dislocation of locomotor coordination in certain small plectognath fishes by sudden changes in light intensity. This was sufficient to cause the fishes to tumble or spin in various manners at remarkable speed. Historically, the study was started when Breder, at the Tortugas Laboratory of the Carnegie Institution of Washington in Florida in 1929, made note of this peculiarity of behavior. Harris, visiting there in 1934, extended these observations and the combined notes formed the basis of their joint paper.

Attempts to obtain similar results with material living in the old New York Aquarium or specimens caught summers in or about New York Harbor always failed completely to show these reactions. This led Breder and Harris (1935) to write, "It is strange that fish in the New York Aquarium have

never been seen to gyrate in this manner. The sudden flashing on of a strong light may cause an uneasiness and in some cases excited movement, but never, in a period of some thirteen years, has a disturbance of equilibrium attributable to light stimuli been noted." Since this statement was made the time has extended to twenty-one years despite increasing attention being given to the possibility of such an occurrence. This was not considered especially striking at the time, since long captive fishes or extra-limital strays frequently fail to show typical reactions.

Since the publication of those observations the possible presence of the effect was tested in a number of places on newly caught fishes under conditions essentially similar to those at the Dry Tortugas. None of these places are greatly distant therefrom and are located as follows: Berry Islands and Nassau, winter 1930; Andros Island, Bahamas, winter 1932 and 1933; West Indies "Atlantis" cruise, winter 1934; Palmetto Key, Florida, winter, spring, summer 1938 to 1942 inclusive. At all but the last mentioned place the observations were cursory and not the subject of particular effort. At the field laboratory of the New York Aquarium, on Palmetto Key, an especial effort was made to repeat the results, especially the last year. This place has been occupied intermittently over a period of five years and is approximately 140 miles distant from the Tortugas. Although the two habitats are markedly different there is a considerable number of species common to both. Here too, only failures resulted.

As the matter now stands, so far as the author knows, this phenomenon can only be induced at the Dry Tortugas, similar material from a variety of other places not showing such reactions. There is a two-fold reason for reporting this purely negative item. One is to draw forth, if possible, positive items from other places and the other is to place on record this curiously and apparently geographically limited behavior characteristic. It is only proper to point out to others who may have looked for this bit of behavior and failed to find it, that so far as we are aware it has not been found, even after considerable effort, except at the original place of description. Before discussing the possible implications of the peculiar nature of these later failures, the following details of the most recent attempts are given, comparatively, with the successful ones at the Tortugas.

| | Tortugas | Palmetto Key |
|---|---|---|
| Species | *Monacanthus hispidus* | Same |
| Size of specimens in mm. | 15–50 | 15–45 |
| Dark conditioned | "several" hours | 2 to 7½ hours |
| Water temp. °C. | 27.2 to 29.4 | 26.5 to 32.5 |
| Season | June–July | June–July |

In addition to the *Monacanthus (Stephanolepis) hispidus* (Linnaeus) other material less properly comparable was also used. Thus small *Lactophrys quadricornis* (Linnaeus) *(=L. tricornis)* of 8 mm., smaller than those found at the Tortugas, were used as well as 12 mm. *Cyclichthys schoepfi* (Walbaum) (?), which were not found at the Tortugas.

Many of the variables that come to mind which might be associated with the observed differences can at once be eliminated, as follows. Species

and size of specimens, the same; condition of specimens, indistinguishable; season of year, the same; time of day, afternoon and evening at both places; temperature of water, practically the same; light intensity, same type of three-celled flash lamp. Such items as barometer, tide or moon phase we can see no reason to bring into the discussion, as over the years many of the same periods and conditions must have been accidentally duplicated and furthermore at the Tortugas the effect was obtainable at any time. The chemical composition of the water is clearly different, that at Tortugas being brilliantly transparent and of high density, typical reef water. The Palmetto Key water is of less density, somewhat turbid and notably full of plankton. However, in small aquaria the visibility and light penetration is excellent, and there is no apparent reason why one should suspect that these conditions have anything to do with the situation.

It does so happen that *Monacanthus* is present in vastly greater numbers at Tortugas than at any of the other places mentioned, and it is tempting to suppose that here is a vast reservoir of young fish and that only the successful ones are found elsewhere, those with the disorientation "defect" having been eliminated before traveling far. However there are many reasons to abandon such a view, especially as it must be borne in mind that a variety of non-plectognath fishes at the Tortugas also showed this kind of behavior to a lesser extent.

Lochhead (1942), in discussing proprioception in aquatic animals, refers to the recognition in Breder and Harris (1935) of the possible importance of vision and the otic organs to orientation to certain fishes. The present long chain of negative findings concerning the evident lack of nearly complete visual control of stability is particularly puzzling from this standpoint. It is difficult to see why control by otic means and proprioception is evidently adequate in most places, while in a single locality it can easily be overridden by optical control, or rather be disrupted by its breakdown, induced by very simple means.

Without material showing a vestige of this behavior it is impossible to proceed further at the moment and it is hoped that this note will elicit any existent pertinent information on the matter.

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# Studies on Wisconsin Carp

## 1. Influence of Age, Size, and Sex on Time of Annulus Formation by 1936 Year Class [1]

By David G. Frey

IN 1936 there was an unusually large hatch of carp in the Four Lakes region near Madison, Wisconsin. Through efforts of the Wisconsin Conservation Department to control the carp in these lakes by seining, nearly all the large carp had been removed by the fall of 1938, leaving an almost homogeneous population—the 1936 year class—in the lakes. Since intensive efforts were likewise made to reduce this population with traps and seines, it was a relatively easy matter to obtain frequent samples of the 1936 year class in most months of the year. Growth of this dominant year class was followed over a four-year period in three of the four lakes—Monona, Waubesa, and Kegonsa (3843, 2034, and 3145 acres, respectively). For each fish it could readily be determined whether or not the current annulus had formed. The present study is based on an examination of scales from 4089 carp belonging to the 1936 year class. These scales were mounted on slides in glycerine jelly and studied at a magnification of 66.7 diameters by means of a projection apparatus.

### Time of Formation of First Three Annuli

Most of the 1936 year class hatched during the first half of June in 1936. The first annulus had not been formed by May 3, 1937, but was present on the scales of all fish by the first part of June (Table I, Fig. 1). The small amount of marginal growth indicates that annulus formation had occurred but a short time previously, probably during the third or fourth week in May. Nearly all the fish formed the annulus at the same time, as indicated by the small variation in marginal growth. A similar condition was noted for the 1935 year class whose members all formed the first annulus in late May, 1936.

Whereas the first annulus was formed by all fish at approximately the same time, formation of the second and third annuli extended over considerable periods of time. In fact, there were a few fish in each lake which did not form a second annulus during the third summer, and others which did not form a third annulus during the fourth summer. In the June 27, 1938, sample from Kegonsa, approximately half the fish had the second annulus on their scales; the same was true of the June 21 sample from Monona. The July 25 sample from Monona should really be considered part of the June 21 sample, as the fish therein were caught on June 21 and kept in a holding pond where overcrowding prevented further growth. During July and August there were stragglers (all males) in Waubesa that had not formed the second annulus. Two fish caught in March and April, 1939, had only one annulus on their scales. The large size of these fish and the

[1] The material in this paper represents part of a thesis presented to the Graduate School of the University of Wisconsin in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Collection and organization of the data were made possible by help from the University of Wisconsin, the Wisconsin Conservation Department, and the Works Progress Administration.

marked resorption of the lateral edges of their scales indicated that they did not belong to the very small 1937 year class. Since the marginal growth curve of the July 28 sample from Waubesa indicates that annulus formation had probably taken place recently for some of the fish, the second annulus may be said to have formed on the scales of most fish from middle June to middle July of the third summer.

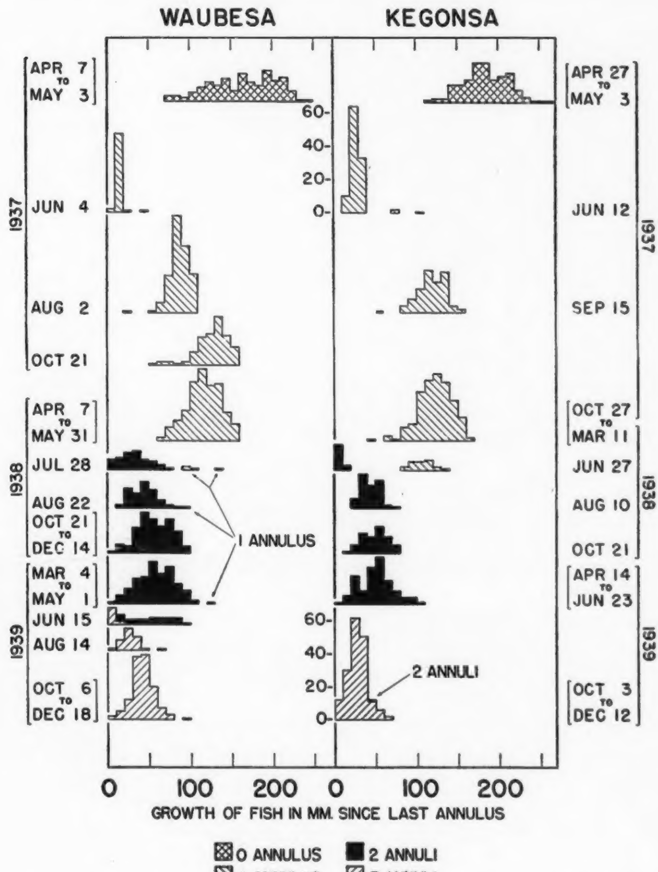


Fig. 1. Seasonal variation in the amount of marginal growth of the 1936 year class carp for the first four years of life.

The third annulus was present on some of the fish taken in Waubesa on June 15 and June 27, 1939, but not on any of the nine carp collected in Kegonsa on June 23. By middle August the third annulus had been

TABLE I

DISTRIBUTION OF THE 1936 YEAR CLASS CARP BY DATE OF COLLECTION AND NUMBER OF ANNULI PRESENT ON THE SCALES

WAUBESA

| Date | Number of annuli 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| 7/17/36 | 131 | | | |
| 7/18 | 68 | | | |
| 9/19 | 87 | | | |
| 10/20 | 46 | | | |
| 10/23 | 11 | | | |
| 11/10 | 30 | | | |
| 12/1 | 115 | | | |
| 12/3 | 25 | | | |
| 12/7 | 24 | | | |
| 1/28/37 | 143 | | | |
| 2/19 | 42 | | | |
| 4/7 | 17 | | | |
| 4/9 | 41 | | | |
| 4/20 | 22 | | | |
| 5/3 | 68 | | | |
| 6/4 | | 51 | | |
| 8/2 | | 151 | | |
| 8/3 | | 85 | | |
| 8/11 | | 106 | | |
| 8/25 | | 93 | | |
| 10/21 | | 110 | | |
| 4/5/38 | | 9 | | |
| 4/7 | | 181 | | |
| 5/31 | | 21 | | |
| 7/28 | | 4 | 49 | |
| 8/22 | | 1 | 58 | |
| 10/21 | | | 59 | |
| 12/6 | | | 29 | |
| 12/14 | | | 34 | |
| 3/4/39 | | 1 | 37 | |
| 4/10 | | | 33 | |
| 4/24 | | | 29 | |
| 5/1 | | | 34 | |
| 6/15 | | | 9 | 5 |
| 6/27 | | | 21 | 8 |
| 8/14 | | | | 30 |
| 10/6 | | | | 50 |
| 10/24 | | | | 32 |
| 11/9 | | | | 36 |
| 12/18 | | | | 9 |
| Totals: | 870 | 813 | 392 | 170 |

KEGONSA

| Date | Number of annuli 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| 7/2/36 | 62 | | | |
| 7/10 | 32 | | | |
| 9/2 | 86 | | | |
| 9/4 | 107 | | | |
| 4/24/37 | 88 | | | |
| 5/3 | 54 | | | |
| 6/12 | | 109 | | |
| 9/15 | | 100 | | |
| 9/24 | | 96 | | |
| 10/27 | | 96 | | |
| 10/29 | | 97 | | |
| 3/11/38 | | 10 | | |
| 6/27 | | 21 | 17 | |
| 8/10 | | | 61 | |
| 10/21 | | | 59 | |
| 4/14/39 | | | 25 | |
| 4/27 | | | 27 | |
| 5/8 | | | 21 | |
| 5/25 | | | 30 | |
| 6/23 | | | 9 | |
| 10/3 | | | | 52 |
| 11/8 | | | 1 | 34 |
| 11/17 | | | | 12 |
| 11/27 | | | | 26 |
| 12/7 | | | | 23 |
| 12/12 | | | | 25 |
| Totals: | 429 | 529 | 250 | 172 |

MONONA

| Date | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| 9/1/36 | 102 | | | |
| 9/16 | 18 | | | |
| 6/16/37 | | 10 | | |
| 4/22/38 | | 95 | | |
| 6/21 | | 21 | 28 | |
| 7/25 | | 11 | 8 | |
| 4/14/39 | | 1 | 45 | |
| 10/9 | | | | 42 |
| 10/27 | | | | 28 |
| 11/22 | | | | 22 |
| 12/6 | | | | 33 |
| Totals: | 120 | 138 | 81 | 125 |

formed by all fish except an occasional straggler (Kegonsa, November 8, 1939). The marginal growth was well advanced on this date except for one fish, indicating that annulus formation had probably been completed

some time previously. Hence, the third annulus formed during the period from the middle of June to the middle or latter part of July of the fourth summer, approximately the same calendar period as that of the second annulus.

Most of the previous studies on the time of annulus formation in fresh-water fishes have been based on the amount of marginal growth shown on the scales, the assumption being made that annulus formation had recently taken place or was taking place when the marginal growth was at a minimum. While this is true for a general picture of the time of annulus formation, it gives no criterion for placing in their proper year classes the fish caught during the period of annulus formation. This difficulty is often avoided by discarding samples collected during this critical period.

Figure 1 shows the progressive changes in marginal growth of the 1936 year class over a 4-year period. Instead of using the marginal growth of the scales in constructing the histograms, the length increments of the fish were used because of the considerable variation in size of key scales from fish of the same length. From a curve showing the length of key scales as a function of fish length, a table was prepared from which the previous lengths of the fish could be determined when the scale measurements were at hand. The length increments or "marginal growths" plotted in Figure 1 are the differences between the measured standard length of each fish and its calculated length at the time of formation of the most recent annulus. Curves for the marginal growth of the scales are quite similar to those in Figure 1, but the coefficients of variation are consistently greater. The seasonal changes are essentially the same.

If one were concerned with a heterogeneous carp population composed of a number of year classes overlapping in length ranges, it would be very difficult, if not impossible, to place summer-caught carp in their proper year classes on the basis of marginal growth alone. For instance, the fish in the June 23, 1939, sample from Kegonsa all had two annuli on their scales, yet the marginal growth of some specimens was very small although it represented the entire previous season's growth. It might be assumed that these latter fish had only recently formed an annulus, and consequently belonged to a different year class than the fish with the greater marginal growth. Similarly, on the basis of marginal growth alone there would be little justification for saying that the fish caught in Waubesa on June 15 and 27, 1939, belonged to the same year class, especially if several other year classes had been present to add to the confusion. When the year class composition of a carp population in a lake is not previously known, it would appear desirable to disregard for year class life history studies all samples collected during the months of June, July, and August, unless the growth rate is sufficiently rapid to prevent overlapping of length-frequency curves for adjacent age-groups. A small error will still be introduced by those few fish which do not grow in length during a season, and consequently do not form an annulus on their scales for that year.

These results on the time of annulus formation agree with earlier observations on the carp. As early as 1900 Walter and Hoffbauer were convinced

from their studies that the scales of carp did not grow during the winter, following closely the observed cessation in growth or even decrease in weight of the fish during this period. Walter concluded, therefore, that the yearly

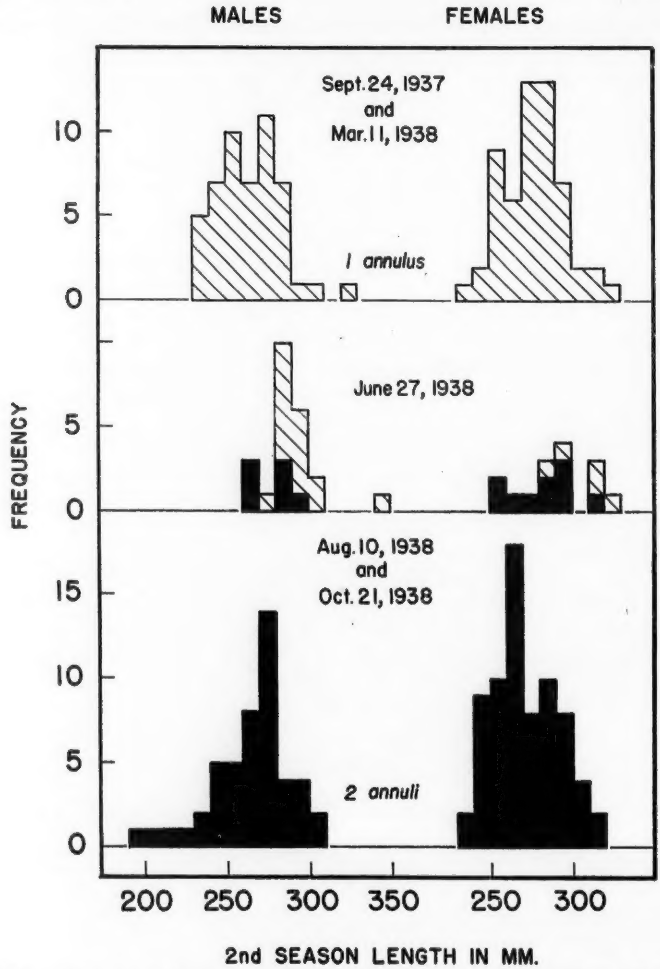


Fig. 2. Frequency histograms for the completed second season length of *Kegonsa* 1936 year class carp to show the variation in time of annulus formation with sex and size of fish. For those fish with two annuli on their scales the calculated second season lengths were used instead of the measured lengths.

growth zones on the scales are entirely the result of the summer growth periods. Pozalujeva (1928) found that carp from the Urga Region of the Aral Sea formed the first annulus from the beginning of April up to May.

Geyer (1939) pointed out that many European cyprinids do not resume growth in a given year until after spawning has taken place.

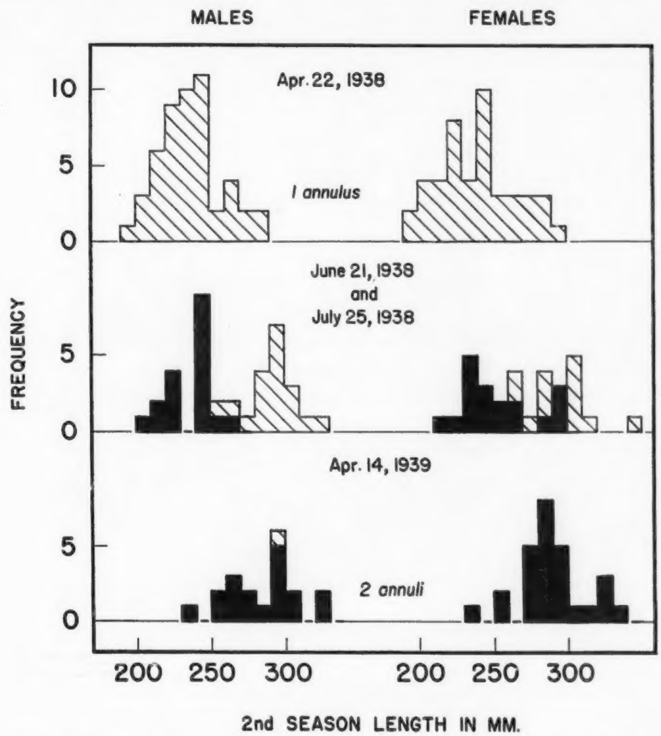


Fig. 3. Frequency histograms for the completed second season length of *Monona* 1936 year class carp to show the variation in time of annulus formation with size and sex of fish.

## Influence of Size and Sex

Several samples, at least one from each of the three lakes being investigated, were collected during the period of annulus formation. These samples are represented by length-frequency histograms in Figures 2, 3, and 4. For comparison in each figure a sample collected before annulus formation had begun and another after annulus formation had been completed by all fish are also shown. The length used is the standard length of the fish at the time of annulus formation: in spring before the current annulus had formed the measured standard length of the fish was used; after the annulus had formed, the length used was the calculated standard length obtained from a curve showing growth of a special scale with respect to length of the fish. This method of obtaining previous lengths eliminates those errors arising from disproportionate growth of scales and fish length. For each sex in Figures

2 and 4 the differences between the means of the initial and final frequency histograms are not significant, attesting to the validity of the method. The progressive shift with time of the mean size of each sex in Figure 3 must be attributed to something other than the method.

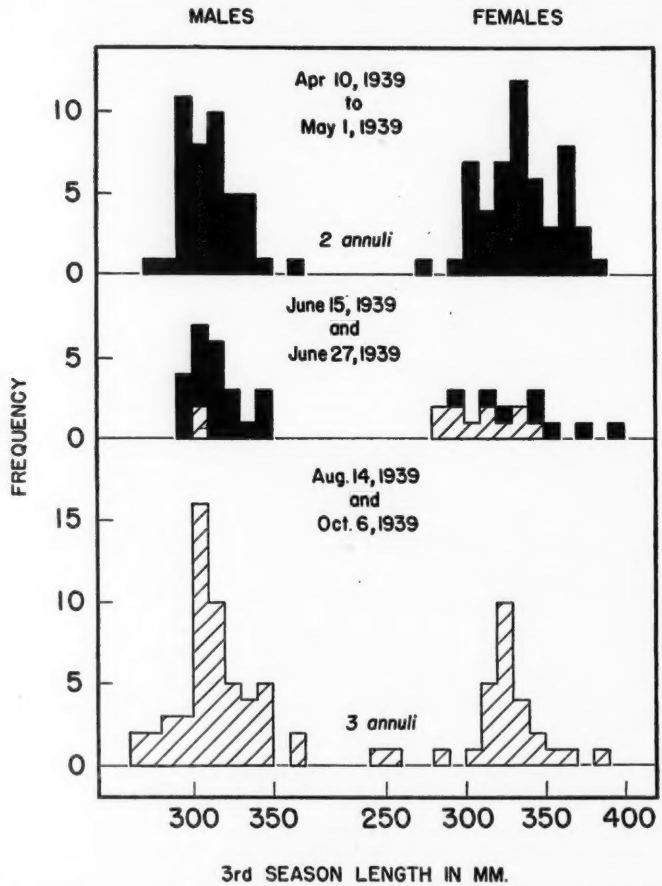


Fig. 4. Frequency histograms for the completed third season length of *Waubesa* 1936 year class carp to show the variation in time of annulus formation with sex and size of fish.

## Size

It was pointed out earlier that the first annulus was formed by all members of the 1936 year class at approximately the same time, large and small fish alike and both sexes alike. In the formation of the second and third

annuli, however, there was a distinct tendency, clearly evident in the figures, for small fish of either sex to form annuli earlier than larger fish of the same sex and age. The mean lengths of the fish with and without the current annulus on their scales (Table II) confirm this observation. In every case the mean standard length of those fish which had already formed the current annulus was smaller than that of those who had not yet formed the annulus.

Table II

Frequencies and mean standard lengths at time of annulus formation of 1936 year class samples collected during period of annulus formation. In each lake the means for fish with the greater number of annuli are based on calculated lengths at the time of annulus formation instead of measured lengths.

| Lake | Date of sampling | No. of annuli on scales | Males No. | Males Mean std. length, mm. | Females No. | Females Mean std. length, mm. |
|---|---|---|---|---|---|---|
| Monona | June 21 and | 1 | 19 | 290.3±3.86 | 13 | 295.7± 6.17 |
| | July 25, 1938 | 2 | 18 | 235.3±3.82 | 18 | 251.5± 5.75 |
| Kegonsa | June 27, 1938 | 1 | 16 | 292.3±3.90 | 5 | 305.6± 7.83 |
| | | 2 | 7 | 276.4±5.05 | 10 | 281.0± 6.32 |
| Waubesa | June 15 and | 2 | 22 | 313.8±3.33 | 8 | 342.6±10.23 |
| | June 27, 1939 | 3 | 2 | 304.5±4.47 | 11 | 314.0± 6.54 |

These differences in the Monona fish are highly significant; those for the Kegonsa fish and the Waubesa females could occur by chance alone once in ten times, and hence would usually not be considered significant; the difference for the Waubesa males is not significant. Because of the great variability in the material it would have been desirable to obtain larger samples, in which event it is likely that all the differences would have been significant.

## Sex

It was also noted that in the formation of the second and third annuli (but not the first) there was a definite tendency for females to form the current annulus earlier than the males. This is shown by the fact that the histograms for the female carp have a greater proportion of their areas represented by the current annulus than do those for the males. Frequencies are given in Table II. The differences for Waubesa are highly significant (chi-square with correction for continuity); those for Monona and Kegonsa are not significant. For Kegonsa just one more fish in the proper column would have made the differences significant to the 5 per cent point. Hence, again it is likely that larger samples would have increased the validity of the results.

## Discussion of Results

Beginning with the second summer (1937) there was a progressive decrease with respect to time in the total amount of variation for each sex in the population of each lake. In general, the smaller a fish was at the beginning of a season the greater was its length increment for that season. Since the small fish also formed their annuli earlier than larger fish it appears likely they had a longer effective growing season. The rate of growth, however,

also varied, as indicated by the marked decrease in variation which occurred during the second summer after all fish had formed the first annulus at approximately the same time.

During the first two summers there were no significant differences in growth between males and females, but thereafter the females grew at a more rapid rate. This is closely correlated with the earlier formation of the second and third annuli by females than by males, indicating that the former probably had a longer effective growing season.

According to a number of investigators (Wunder, 1934; Walter, 1934) the growth rate of a fish is slowed when it becomes sexually mature. It has been noted by these same investigators that male carp mature on the average one year earlier than the females. In the Wisconsin material at the beginning of the third summer 92 per cent of the males but only 7 per cent of the females were mature and ready to spawn. No fish of either sex were mature at the beginning of the second summer. The first annulus was formed by all fish at the same time, but the second and third annuli were formed earlier by females than males.

Variation in time of annulus formation with size and sex would be expected from one lake to another, depending on productivity, population density, and other factors affecting growth rate. Geyer (1939) concluded for some European cyprinids that in general the faster the growth rate in a population the less difference there was in size and growth between males and females; the converse was also true. Likewise, the faster the growth rate the more nearly did males and females reach maturity at the same time. If the average growth rate was slow, the males matured earlier and thereafter grew more slowly than the females.

## Failure of Some Fish to Form Annuli

Growth of a fish is indeterminate. Under favorable conditions there is a growth increment each year; under unfavorable conditions there may be none, at least for some of the fish. In this particular study two fish failed to form the second annulus, and one failed to form the third annulus. This is a very small proportion of the total number of fish examined but illustrates a type of error which can easily pass unnoticed in a life history study.

## Conclusions

1. This study is based on 4089 carp of the 1936 year class collected over a four-year period from lakes Monona, Waubesa, and Kegonsa near Madison, Wisconsin.

2. Regardless of size or sex the first annulus was formed on the scales of all fish at approximately the same time in late May, 1937. It was also noted that the first annulus of the 1935 year class was formed in late May, 1936.

3. The second annulus appeared on the scales of most fish from middle June to middle July, 1938.

4. The third annulus was formed from middle June to middle or late July, 1939.

5. Sex and age being equal, small fish tended to form the second and third annuli earlier than large fish, in close agreement with a marked decrease in variation in the populations.

6. Size and age being equal, females tended to form the second and third annuli earlier than the males. This is correlated with the earlier maturity and subsequent slower growth of the males.

7. A few fish did not exhibit any growth increment in a given year, and consequently formed no annulus for that year.

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United States Fish and Wildlife Service, College Park, Maryland.

# Some Observations on the Reproductive System of the Yellow Perch (*Perca flavescens*)

By J. B. Parker

IN the female of the yellow perch there is but a single ovary, which lies on the midline in the body cavity above the alimentary canal and below the swim bladder. In the adult female no oviduct is present and there is no connection whatever between the reproductive and urinary systems. The ovary is enclosed in a membrane forming what is termed the ovarial sac, of which the posterior ventral area, between the anus and the urinary orifice, is fused with the body wall (Fig. 3 os). In this species the ripe eggs escape from their follicles into a central cavity within the ovary itself, from which, embedded in a gelatinous substance, they are discharged directly from the ovary to the outside.

Due to pressure from within, as the time for oviposition approaches, a conspicuous papilla (Fig. 1 p) forms on the ventral midline involving the

area between the anus and the urinary orifice, which area marks the point at which the ovarial sac and the body wall coalesce, and which becomes inflamed and greatly distended. The papilla thus formed practically conceals the urinary orifice and greatly distends and distorts the anal opening (Figs. 2 a, 3 a). Just prior to the rupture of this papilla the tissue covering its extremity becomes so thin and transparent that the eggs can readily be distinguished through it. In due time, because of increased pressure from within, this papilla ruptures and through the orifice thus formed (Figs. 1, 2, 3 ro) the eggs are discharged from the ovary (Fig. 3 o) in an unbroken, zigzag ribbon-like gelatinous mass, the form of which corresponds almost exactly to the form of the cavity within the ovary.

In some fishes there is a median abdominal pore situated between the anus and urinary orifice through which the eggs are discharged. Whether such a pore is formed in the development of the young perch and later is lost the author cannot say, since all his observations have been based on mature specimens. All the evidence so far obtained, however, leads to the conviction that no such pore exists in the adult fish and that the opening through which the eggs are discharged represents a true, although temporary, rupture. This ruptured orifice (Figs. 1, 2 ro) is relatively very large. On one female 8 inches in length the opening was five-eighths of an inch in diameter. After oviposition the opening closes rapidly and in time disappears.

In the male of this species there is a pair of testes located in the body in a position similar to that of the ovary in the female. The two testes, however, are united along their median surfaces by a septum for about one-third their length at their posterior ends. This septum, perforated near its anterior end by an opening joining the cavities of the two testes, terminates near the posterior ends of the testes where a single duct arises. At a short distance from its origin this duct is enlarged to form what may be considered a seminal vesicle (Fig. 5 sp), from which a short duct extends downward and unites with the urinary duct just above the urinary orifice (Figs. 4, 5 spd). Although the urinary duct and sperm duct discharge their contents through a common opening, the juncture of the two ducts is so close to the common opening that it may safely be said that at no time does the sperm traverse any part of the urinary passageway. Although at this time the author cannot furnish positive proof, nevertheless the evidence at hand indicates that the opening of the sperm duct into the urinary duct is caused by rupture; in other words, there is no opening between the two ducts save at the time one becomes imperative for the discharge of the sperm.

In submitting this short article for publication the author desires to state that he has not made an exhaustive search of the literature dealing with the reproductive systems of fishes. So far as his search has been carried, however, he has found nothing dealing with the reproductive system of the yellow perch, save some bits of misinformation appearing in certain college texts, including one sponsored by the present author. It is hoped that the publication of this article may call attention to the need of more careful and more extensive study of the anatomy and physiology of some of our common fishes.

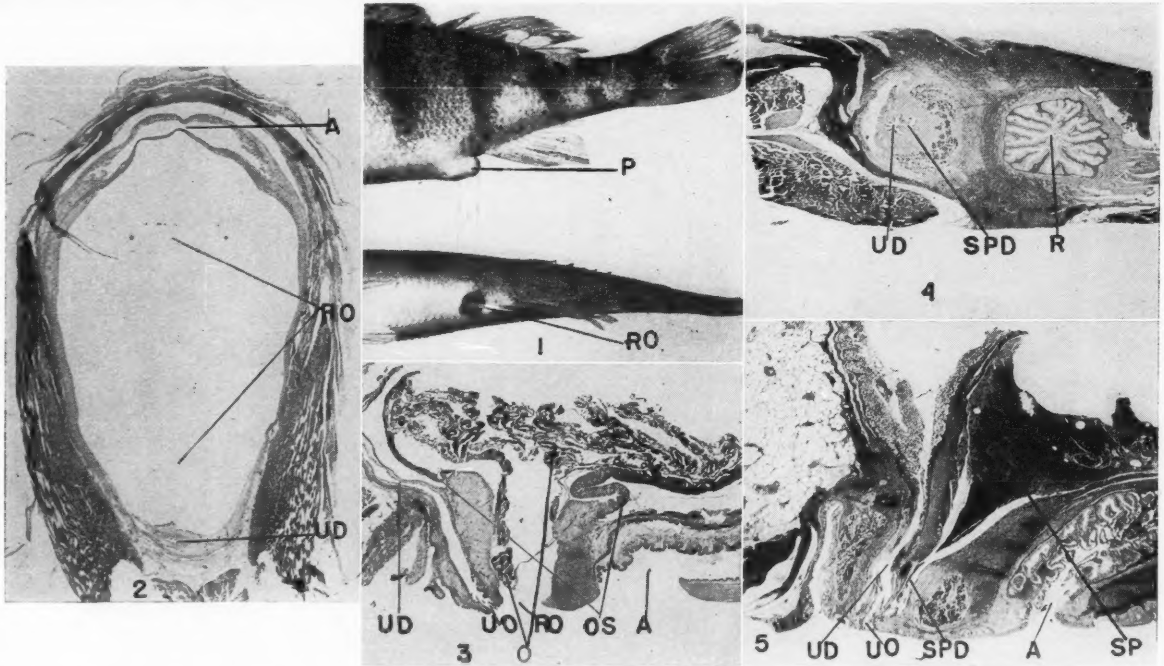


Fig. 1. Female yellow perch; lateral view showing papilla, ventral view showing ruptured orifice filled with eggs (×½). Fig. 2. Section of papilla, showing cross sections of anal opening, urinary duct, and ruptured orifice (× 5). Fig. 3. Longitudinal, median, vertical section through papilla made immediately after completion of oviposition (×7½). Fig. 4. Male. Section made in a plane parallel to the ventral surface and at right angle to the median vertical plane of the body, showing cross section of rectum (r) and of the sperm duct (spd) and of the urinary duct (ud) at their point of junction (×7½). Fig. 5. Male. Section parallel to the longidtudinal median vertical plane of the body through the region illustrated in Fig. 4. The urinary orifice and the junction of the two ducts is somewhat obscured by sperm forced down from the mass above (sp) at the time the specimen was killed (XII). a—Anal opening. os—Ovarial sac. p—Papilla. r—Rectum. ro—Ruptured orifice, for discharge of eggs. sp—Mass of sperm, in seminal vesicle. spd—Sperm duct. ud—Urinary duct. uo—Urinary orifice.

The photographs used in the illustrations were made by Mr. R. M. Reeve, to whom the author's thanks are due. All material used was obtained by first killing the fish and then plunging its body into 10% formaldehyde for hardening and fixing. That used in making sections was afterward cut out, treated with Bouin's fluid, embedded in paraffin, sectioned, and stained with Mallory's Connective Tissue Stain.

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# On Fishes Confused with *Caranx kalla* Cuvier and Valenciennes

By J. T. Nichols

AMONG East Indian Carangin fishes collected in 1941 by the Instituut v.d. Zeevisscherij at Batavia, and received at the American Museum of Natural History, species of *Caranx* placed in the subgenus *Selar* by Weber and de Beaufort (1931, Fishes Indo-Austral. Archipel., VI: 205-219) are of particular interest, as their treatment of this group is less satisfactory than that of various others.

They, and other authors, have confused three quite unlike though doubtless closely related fishes, which have ventral outline of the body deeper, more convex than the dorsal, as *Caranx kalla* Cuvier and Valenciennes. The situation is probably best explained by a comprehensive super-species in a state of evolutionary flux in two directions, likely made up of several minor groups which may or may not be worth taxonomic recognition, and may be more or less intermediate. I believe the most satisfactory procedure will be to recognize the three resultant categories as species; minor or side variations, when advisable, as subspecies. My unwillingness to leave the three in one species may be explained by saying that they from the most standardized, related to *Caranx mate*, to the most aberrant, about half bridge the gap to the aberrant genus *Chloroscombrus*, which, prior to examining this material, I have always hestitated to include in the subfamily Caranginae, and for which a monotypic subfamily is sometimes recognized.

## *Caranx kalla* Cuvier and Valenciennes

*Caranx kalla* Cuvier and Valenciennes, 1833, Hist. Nat. Poiss., IX: 49; Pondicherry. Weber and de Beaufort, 1931, *l.c.*: 216 (in part); East Indies.

*Selar kuhlii* Bleeker, 1851, Nat. Tijd. Ned. Ind., I: 360; Batavia. But not *Caranx kuhlii*, Fowler, 1928, Fish. Oceania: Pl. XII, A; Oahu, which is at least closer to *C. mate lundini*.

This form is represented in the above-mentioned collection by four specimens, one of 128 and three of 141 to 147 mm. standard length, from Sumatra and Batavia. To these we may add two specimens of 125 and 129 mm. in the American Museum collection (No. 1569, labelled *djeddaba*),

Batavia, 1909, Bryant and Palmer. This seems to be a fairly standardized form, varying little with size, as has been found for *C. m. lundini* (COPEIA, (3) 1938: 144). Comparing the three larger, 141 to 147 (average 144) mm. specimens with the 3 smaller of 125 to 129 (127) mm., depths are respectively 2.9 to 3 (average 2.97), 2.9 to 3.1 (3.0); head, 3.8 to 3.9 (3.87), 3.8; eye, 3.5 to 3.6 (3.53), 3 to 3.5 (3.3); maxillary 2.5 to 2.6 (2.57), 2.6 to 2.7 (2.63); greatest width, 1.9 to 2 (1.93), 1.9 to 2.4 (2.1); pectoral, 0.8, 0.9; curve (chord) in straight part lateral line, 1.8 to 1.9 (1.87), 1.9 to 2.2 (2.07). The dorsal and anal soft rays of the six specimens are constant, 23, 19. Scutes vary from 43 to 48 (average 45.5).

They agree with *C. mate* in being long bodied (though appreciably deeper) and small headed, having high sheathes to soft dorsal and anal fins, numerous gill-rakers (perhaps slightly fewer, about 25 on lower limb of arch), and have a similar black opercular spot, though lacking trace of the *mate* cross bars.

The last dorsal and anal ray is somewhat enlarged and separated as in *mate*. Weber and de Beaufort use this character to differentiate *mate* from its close allies, but it is not good; *kalla* at least has it also, though it may average best developed in typical *C. m. mate*. They have the lower jaw less projecting, ventral part of the body more compressed, deeper and more convex than the back, as described. This is a good character, though variable in degree, and the ventral outline is not trenchant, or only relatively so. The upper lobe of the caudal is appreciably longer than the lower. The most conspicuous difference from *mate* is, of course, the relatively much longer, armed straight part, and short, more abrupt curve of the lateral line.

I have compared these specimens with the original description of *Caranx kalla* Cuvier and Valenciennes, with which they agree well. They may be close to *C. djeddaba* as recognized from the East Indies, which I have not seen.

### *Caranx brevis* (Bleeker)

*Selar brevis* Bleeker, 1851, Nat. Tijid. Ned. Ind., I: 361; Batavia.

Though *Caranx brevis* is not represented in the Batavia Collection, we have a specimen from Manila, collected by Seale, 107 mm. in standard length (Amer. Mus. No. 3923). Though evidently related to *kalla* it is much shorter, deeper bodied, more compressed and trenchant, mouth more strongly oblique (about 45 degrees), lower jaw more projecting, last vertical fin rays appreciably enlarged but not separated. The absolute measurements of its depth and eye are greater than those of the 128 mm. *kalla*, of its head almost identical. The ventral outline is deeper than the back as in *kalla;* gill-rakers about 28 on lower limb; dorsal and anal soft rays, 23, 19; front of soft dorsal and anal with deep sheathes; an abrupt curved and long straight part of the lateral line, with one or two anterior scutes extending on to the curve. Caudal lobes broken. Depth, 2.4; head 3.6. Eye, 3; snout, 4.1; maxillary, 2.4; width, 2; length of peduncle, 2.5; pectoral, 0.9. Curve in straight part lateral line, 1.8. Scutes 38.

We are quite familiar in some carangins with changes in body form with

size as great or greater than the difference between *brevis* and *kalla,* but these are gradual and progressive, not metamorphic as they would have to be to take place between 107 and 125 mm., and leave no trace between 125 and 147 mm. Furthermore, we may argue from analogy with related *C. mate,* that *kalla* undergoes no such changes.

### *Caranx queenslandiae* (de Vis)

*Micropteryx queenslandiae* de Vis, 1884, Proc. Linn. Soc. N. S. Wales, 9, pt. 3: 541; Queensland.

*Alepes kalla,* Ogilby, 1915, Mem. Queensl. Mus., 3: 62, Pl. XX; Queensland. Not *Caranx kalla* Cuvier and Valenciennes.

This species approaches the peculiar body form of the aberrant genus *Chloroscombrus* (equals *Micropteryx,* Günther and others, not of Agassiz). The back is little elevated as in *kalla,* but the belly deeper and more convex in outline; the body tapers backward more to a more slender caudal peduncle, than in *brevis* especially; the arch of the lateral line slants back more to join the straight part at a wider angle; the upper lobe of the caudal fin is more considerably longer than the lower; the first anal spine is equidistant from tip of snout and base of last anal ray, versus middle of peduncle in *kalla,* base of caudal in *brevis;* the black opercular blotch extends more on the shoulder. Critical characters of the three species may be summarized as follows:

Oriental *Caranx* with small head; jaws subequal or lower projecting, with small, equal teeth tending to be uniserial; numerous slender gill-rakers, 25 to 30 on the lower limb of the arch; ventral outline of body more convex than dorsal; vertical fins not greatly elevated in front with well-developed sheathes; pectoral more or less longer than head; breast scaled; straight, armed part of lateral line about 1.5 to 2 times the chord of the curve.

1. Elongate, depth about 3. Back little elevated, head and nape scarcely keeled, belly compressed but not trenchant. Curve lateral line in straight part 1.8 to 2.2. Scutes 43 to 48. First anal spine equidistant tip of snout and middle of peduncle. Last ray of vertical fins appreciably enlarged and separated .......................................... *C. kalla*

2. Short-bodied, depth about 2.4. Back elevated, head and nape sharply keeled, belly trenchant. Curve of lateral line in straight part about 1.8. Scutes 38 to 40. First anal spine equidistant tip of snout and base of caudal ........................... *C. brevis*

3. Deep, but tapering behind, depth 2.3 to 2.5. Back little elevated, head and nape little keeled; belly deep, compressed, trenchant. Curve of lateral line in straight part 1.5 (or less) to 1.95. Scutes 41 (or less) to 45. First anal spine equidistant tip of snout and base last anal ray [nearer tip of snout in the genus *Chloroscombrus*]. Last ray of vertical fins not at all separated ............................................ *C. queenslandiae*

Ogilby (*l.c.*) describes *queenslandiae* in detail and gives a figure of it. In the collection received from Batavia there is a single specimen very suggestive of this figure, but even more than it is, like the genus *Chloroscombrus.*

### *Caranx queenslandiae* **chloroscombroides,** new subsp.

A *Caranx* related to *C. kalla* and *C. brevis,* with a low back, more nearly vertical mouth, very deep, compressed, trenchant breast, so that the ventral outline is much more convex than the dorsal; tapering to a slender peduncle. Curve of the lateral line somewhat less abrupt and longer in relation to the straight part than in these species. The first anal spine is equidistant from

tip of snout and base of last anal ray, in *brevis* equidistant from tip of snout and base of caudal, in *kalla* from tip of snout and middle of peduncle.

Description of Type.—No. 15942 American Museum of Natural History, from Java or Sumatra (exact data lost), collected by the Instituut v. d. Zeevisscherij.

Length to base of caudal, 122 mm. Depth in this length, 2.5; head, 4. Eye in head, 3.2; snout, 4; maxillary, 2.4; greatest width, 1.9; length of peduncle, 2; pectoral, 0.9. Depth of peduncle in eye, 1.5. Curve (chord) in straight part of lateral line, 1.5.

Dorsal soft rays, 23; anal, 20. Scutes, 44. Gill-rakers (lower limb of arch), 28.

Head small, blunt; eye high, and far forward, its hind rim about equidistant from tip of snout and edge of gill-cover; mouth subvertical with slightly projecting lower jaw; soft vertical fins in front little elevated and with a deep sheath, as in *kalla;* upper caudal lobe about 1/4 longer than lower; last vertical fin rays slightly enlarged and lengthened, but not at all separated. Teeth in jaws small, in a very narrow band of two irregular rows. Tip of a heavy, blunt, procumbent forwardly-directed spine exposed behind the vent. A black opercular blotch as in *kalla,* but extending more on the shoulder; no other markings.

In most characters and measurements this fish agrees with Ogilby's description and figure of *queenslandiae.* The double row of teeth may be an abnormality or might be overlooked, as also the exposed tip of a forwardly-directed spine behind the vent. Its fewer dorsal and anal rays, 23, 20, versus 25 or 26, 21 or 22, seems to be a matter of minor taxonomic significance. Ogilby says "As has been remarked elsewhere there is a tendency among Australian specimens towards an increase in the number of dorsal and anal rays." Other differences which it shows are a more vertical mouth, deeper breast with a steeper front outline, a more posterior origin of the soft dorsal, its distance from the base of caudal only slightly greater than that from the tip of snout, and a relatively longer curve of the lateral line, 1.5 versus 1.8 to 1.95 in straight part.

In the evolutionary line from *kalla* toward the genus *Chloroscombrus,* Day's figure of *kalla* seems to be intermediate between specimens of *kalla* examined and *queenslandiae; queenslandiae* intermediate between Day's figure and *chloroscombroides.* *Caranx miyakamii* Wakiya from Formosa is of the species *queenslandiae* as here defined, and seems to be a third recognizable race of the same.

*Caranx malam* (Bleeker), also recognized as a member of the subgenus (*Selar,* equals *Atule*), is an approach to the carangin genus *Hemicaranx* (which was long ago noticed by Day, 1878-1888, Fish. India: page 226, under *nigripinnis,* equals *malam*), just as *Caranx queenslandiae* is to *Chloroscombrus.* The world range of both *Chloroscombrus* and *Hemicaranx* is limited to both sides of the Atlantic and the American Pacific. These facts are of interest in speculation as to the place of the subgenus *Selar* in the evolution and dispersal of the Caranginae.

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# Scale Reduction Studies[1] in Certain Non-Colubrid Snakes

By PHILIP J. CLARK and ROBERT F. INGER

IN a recent paper on scale row reduction in snakes we have attempted a critical analysis of the general subject, based mainly on snakes of the family Colubridae. We have now examined 50 specimens of the various non-colubrid families Boidae, Pythonidae, Elapidae, Crotalidae, and Viperidae. On the whole we find no fundamental differences in the reduction patterns of these families from those that characterize the Colubridae. We are again grateful to the authorities of Field Museum of Natural History for permission to consult the reference collection and for laboratory space. Messrs. Karl P. Schmidt and Clifford H. Pope have continued their helpful advice and criticism.

In species with an unusually large number of scale rows the reductions are frequently irregular and assymetrical, occurring at different levels on the body, as notably in the colubrid *Spalerosophis maximus*. This is naturally true of the boas and pythons, in which there may be as many as 95 scale rows. In species of these families with a low number of scale rows, the reductions may very nearly correspond on both sides of the body. In species with a large number of scale rows the reductions often become more symmetrical on the posterior part of the body, where the number of rows decreases.

Various vipers have a diagonal arrangement of the scale rows that is very different from the usual snake type. In most snakes the scale rows are arranged so that they form nearly straight rows in three directions: longitudinally (from the head backwards), in a diagonal direction upward and backward, and diagonally upward and forward from the ventrals. This is the *simple longitudinal type.* In the so-called *oblique type* of scale arrangement, the transverse rows are curved, though the longitudinal rows are still parallel to the axis of the body. Various degrees of obliquity may be recognized. Differing sharply from these types is the *diagonal arrangement* of the dorsal scales in which the longitudinal rows are not parallel to the axis of the body, but are directed downward and backward.

In the primitive family Boidae the number of dorsal scale rows ranges from 23 to 95. *Tropidophis,* with relatively few scale rows, has a scale formula comparable with that of the colubrid snakes.

*Tropidophis pardalis canus* (Cope)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventral No.— | | 10 | | 57 | | 125 | | 147 | | 160 | | 173 |
| FMNH 279 | 23 | $\left\{\begin{matrix}5+6\\ \ldots\\ 5+6\end{matrix}\right\}$ | 21 | $\left\{\begin{matrix}5=5+6\\ \ldots\ldots\\ 5=5+6\end{matrix}\right\}$ | 23 | $\left\{\begin{matrix}5+6\\ \ldots\\ 5+6\end{matrix}\right\}$ | 21 | $\left\{\begin{matrix}3+4\\ \ldots\\ 3+4\end{matrix}\right\}$ | 19 | $\{9+10+9\}$ | 17 | |
| Ventral No.— | | 10 | | 52 | | 126 | | 145 | | 160 | | 173 |

In some species of *Enygrus (Enygrus asper,* for example), the scutellation

[1] An appropriate name for this department of herpetological studies can be derived from the Greek *psolos,* snake scale, and *meimos,* reduction in number. We are indebted to Dr. Fritz Haas, Curator of Lower Invertebrates at Field Museum for this suggestion. Psolidomeiomology is the complete term.

is of the diagonal type. The longitudinal rows proceed from the vertebral region caudad and ventrad.

In the Pythonidae, also with a large number of scale rows, the elaborate formula for *Calabaria* is the simplest we have found in this family.

*Calabaria reinhardti* (Schlegel)

$$\text{FMNH 19479}\quad 29\underset{43}{\overset{45}{\begin{pmatrix}5=5+6\\ \cdots\\ 5=5+6\end{pmatrix}}}31\underset{56}{\overset{56}{(16=16+16)}}32\underset{80}{\overset{73}{\begin{pmatrix}6=6+7\\ \cdots\\ 5=5+6\end{pmatrix}}}34\underset{132}{\overset{132}{(17+17)}}33\underset{151}{\overset{157}{\begin{pmatrix}4+5\\ \cdots\\ 4+5\end{pmatrix}}}$$

$$31\underset{195}{\overset{196}{\begin{pmatrix}3+4\\ \cdots\\ 3+4\end{pmatrix}}}29\overset{197}{\begin{pmatrix}14+15\\ \cdots\end{pmatrix}}28\underset{220}{\overset{220}{(14+14)}}27\quad\underset{235}{\overset{235}{\vphantom{0}}}$$

In the Elapidae, reductions are much as in the Colubridae. Oblique scale rows may be associated with a large number of rows, as in *Naja nigricollis*; but may equally be associated with a low number, as in *Dendraspis*.

The increase of scale rows on the expansible hood of cobras is correlated with the development of this structure. This is well shown by the common cobra.

*Naja naja naja* (Linnaeus)

$$\text{FMNH 26842}\quad 29\underset{9}{\overset{8}{\begin{pmatrix}9=9+10\\ \cdots\\ 8=8+9\end{pmatrix}}}31\underset{12}{\overset{10}{\begin{pmatrix}9+9+10\\ \cdots\\ 10=10+11\end{pmatrix}}}33\underset{13}{\overset{12}{\begin{pmatrix}6+7\\ \cdots\\ 7+8\end{pmatrix}}}31\underset{14}{\overset{15}{\begin{pmatrix}6+7\\ \cdots\\ 7+8\end{pmatrix}}}29\underset{18}{\overset{18}{\begin{pmatrix}7+8\\ \cdots\\ 8\end{pmatrix}}}27\underset{21}{\overset{20}{\begin{pmatrix}6+7\\ \cdots\\ 6+7\end{pmatrix}}}$$

$$25\underset{26}{\overset{24}{\begin{pmatrix}7+8\\ \cdots\\ 7+8\end{pmatrix}}}23\underset{101}{\overset{107}{\begin{pmatrix}5+6\\ \cdots\\ 5+6\end{pmatrix}}}21\underset{117}{\overset{118}{\begin{pmatrix}4+5\\ \cdots\\ 4+5\end{pmatrix}}}19\underset{122}{\overset{124}{\begin{pmatrix}4+5\\ \cdots\\ 4+5\end{pmatrix}}}17\underset{141}{\overset{138}{\begin{pmatrix}2+3\\ \cdots\\ 2+3\end{pmatrix}}}15\quad\underset{191}{\overset{191}{\vphantom{0}}}$$

*Naja hannah,* a cobra with a reduced hood, exhibits only a single row increase on the neck.

$$\text{FMNH 25753}\quad 19\underset{5}{\overset{7}{\begin{pmatrix}6=6+7\\ \cdots\\ 6=6+7\end{pmatrix}}}21\underset{13}{\overset{13}{\begin{pmatrix}5+6\\ \cdots\\ 5\end{pmatrix}}}19\underset{20}{\overset{18}{\begin{pmatrix}5+6\\ \cdots\\ 4+5\end{pmatrix}}}17\underset{24}{\overset{25}{\begin{pmatrix}4\\ \cdots\\ 4+5\end{pmatrix}}}15\quad\underset{256}{\overset{256}{\vphantom{0}}}$$

*Naja nigricollis,* a cobra without a hood, does not have any increase of the rows on the neck.

$$\text{FMNH 17658.}\quad 27\underset{14}{\overset{12}{\begin{pmatrix}5\\ \cdots\\ 5+6\end{pmatrix}}}25\underset{19}{\overset{19}{\begin{pmatrix}4+5\\ \cdots\\ 5+6\end{pmatrix}}}23\underset{114}{\overset{112}{\begin{pmatrix}5+6\\ \cdots\\ 4+5\end{pmatrix}}}21\underset{122}{\overset{121}{\begin{pmatrix}4+5\\ \cdots\\ 4+5\end{pmatrix}}}19\underset{131}{\overset{131}{\begin{pmatrix}3+4\\ \cdots\\ 3+4\end{pmatrix}}}17\underset{145}{\overset{144}{\begin{pmatrix}3+4\\ \cdots\\ 3+4\end{pmatrix}}}15\quad\underset{192}{\overset{192}{\vphantom{0}}}$$

*Bungarus fasciatus* may be taken as an example of an elapid with typically colubrid scale reductions.

$$\text{FMNH 11542}\quad 19\underset{8}{\overset{9}{\begin{pmatrix}4+5\\ \cdots\\ 3+4\end{pmatrix}}}17\underset{14}{\overset{14}{\begin{pmatrix}3+4\\ \cdots\\ 3+4\end{pmatrix}}}15\quad\underset{206}{\overset{206}{\vphantom{0}}}$$

In the Crotalidae examined, reduction is essentially of the colubrid type. The following formulae exhibit typical reductions in this family.

*Crotalus cerastes* Hallowell

FMNH 26163 $$29\overset{7}{\underset{5}{\begin{Bmatrix}5+6\\ \cdots\\ 5+6\end{Bmatrix}}}27\overset{9}{\underset{8}{\begin{Bmatrix}5+6\\ \cdots\\ 5\end{Bmatrix}}}25\overset{13}{\underset{13}{\begin{Bmatrix}5+6\\ \cdots\\ 5+6\end{Bmatrix}}}23\overset{19}{\underset{18}{\begin{Bmatrix}4+5\\ \cdots\\ 4+5\end{Bmatrix}}}21\overset{104}{\underset{105}{\begin{Bmatrix}4+5\\ \cdots\\ 4+5\end{Bmatrix}}}19\overset{126}{\underset{127}{\begin{Bmatrix}3+4\\ \cdots\\ 4+5\end{Bmatrix}}}17\quad\overset{144}{\underset{144}{}}$$

*Agkistrodon halys* (Pallas)

FMNH 21978 $$23\overset{11}{\underset{8}{\begin{Bmatrix}4+5\\ \cdots\\ 4+5\end{Bmatrix}}}21\overset{96}{\underset{96}{\begin{Bmatrix}4+5\\ \cdots\\ 3+4\end{Bmatrix}}}19\overset{113}{\underset{112}{\begin{Bmatrix}4+5\\ \cdots\\ 4+5\end{Bmatrix}}}17\quad\overset{140}{\underset{140}{}}$$

*Trimeresurus nigroviridis marchi* (Barbour and Loveridge)

FMNH 37217 $$23\overset{9}{\underset{9}{\begin{Bmatrix}5+6\\ \cdots\\ 5\end{Bmatrix}}}21\overset{15}{\underset{16}{\begin{Bmatrix}5+6\\ \cdots\\ 4+5\end{Bmatrix}}}19\overset{107}{\underset{108}{\begin{Bmatrix}4+5\\ \cdots\\ 5\end{Bmatrix}}}17\overset{148}{\underset{147}{\begin{Bmatrix}3+4\\ \cdots\\ 3+4\end{Bmatrix}}}15\quad\overset{169}{\underset{169}{}}$$

The scutellation of the Viperidae is highly variable. The scale rows are of the longitudinal type in the majority, but diagonal rows are found in various species even when other species of the same genus have the longitudinal type. Thus *Bitis gabonica* has diagonal rows, whereas other species of *Bitis* have the usual longitudinal scutellation. Diagonal rows appear to be characteristic of the genus *Atheris*. Within the Viperidae, reduction tends on the whole to be more variable than in the Colubridae, Elapidae, or Crotalidae. In those genera of Viperidae in which variability in reduction is the rule, the genetic complex controlling the scale rows is probably simpler than is that of most genera of the three families mentioned above. Correlated with this variability of reduction pattern is a close relationship between diameter of the body and the number of scale rows, especially evident on account of the abrupt tapering of the body in many vipers.

An example of a complex viperid formula is that of *Pseudocerastes fieldi*

FMNH 11062 $$22\overset{19}{\underset{19}{[11+11]}}21\overset{37}{\begin{pmatrix}+11\\ \cdots\end{pmatrix}}22\overset{94}{\underset{92}{\begin{Bmatrix}4+5\\ \cdots\\ 4+5\end{Bmatrix}}}20\overset{97}{\begin{pmatrix}10\\ ..\end{pmatrix}}19\overset{114}{\underset{114}{[10]}}18\quad\overset{138}{\underset{138}{}}$$

The genus *Atractaspis* has been examined because its general body form is so highly modified from the stocky-bodied viperid type, while the large number of scale rows is retained.

*Atractaspis bibronii* Smith

FMNH 12879 $$23\overset{15}{\underset{11}{\begin{Bmatrix}5+6\\ \cdots\\ 5+6\end{Bmatrix}}}21\overset{45}{\underset{48}{\begin{Bmatrix}5=5+6\\ \cdots\cdots\\ 5=5+6\end{Bmatrix}}}23\overset{177}{\underset{172}{\begin{Bmatrix}5+6\\ \cdots\\ 5+6\end{Bmatrix}}}21\overset{223}{\underset{225}{\begin{Bmatrix}5+6\\ \cdots\\ 6+7\end{Bmatrix}}}19\overset{236}{\underset{237}{\begin{Bmatrix}2+3\\ \cdots\\ 2+3\end{Bmatrix}}}17\quad\overset{240}{\underset{240}{}}$$

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University of Chicago, Chicago, Illinois.

# The Reproductive Cycle of the Prairie Rattler

By Hermann Rahn

THIS investigation was prompted by observations on the female reproductive tract of the prairie rattler, *Crotalus v.viridis* Rafinesque, during the winter months. It was noticed that a striking correlation exists between the absence of sperm in the oviduct of post-parturitional specimens with small ovaries, and the presence of motile sperm in females which had large ovaries and had not thrown litters. During the following year more specimens were obtained and approximately equal numbers of both types of mature females were found. An analysis of these cases strongly suggests that on the Wyoming plateau the snakes have a two-year reproductive cycle, in which one year is skipped between each brood of young, and is thus at variance with the more generally accepted view of an annual reproductive cycle. The criteria for the stage of the sex cycle in the various individuals are 1) the condition of the ovary, 2) the condition of the uterus, and 3) the presence or absence of motile sperm in the reproductive tract. The data are discussed under these headings, assuming a two-year reproductive cycle, and summarized with the aid of a diagram (Fig. 1).

## Material and Method

A total of 64 females was collected at various times in the state of Wyoming. Most of the specimens were autopsied within a few days after reaching the laboratory. Exploratory operations were performed on others in order that the viability of sperm could be studied from time to time in the same animal. Sperm smear samples were obtained by a method similar to the one previously described (Rahn, 1940).

The data concerning these specimens are summarized below. All measurements are expressed in mm. and based upon the number of specimens which follow in parentheses.

| | Total No. | Ovarian Follicle Mean Length $\times$ Width | Range of Uterus Width | Uterine Sperm |
|---|---|---|---|---|
| Ripe females | 27 | $25.4 \pm 4.9 \times 12.7 \pm 2.9$ (23) | 4–8 (14) | present |
| Post-partum females | 20 | $5.6 \pm 1.2 \times 3.3 \pm 0.7$ (16) | 4–8 (10) | absent |
| Immature females | 17 | $7.0 \pm 1.9 \times 3.6 \pm 0.5$ (11) | 1–4 (10) | absent |

On the basis of ovarian follicle size, sperm storage and other characteristics dicussed in the text the animals fall into three natural groups: "ripe," post-partum, and immature females. Autopsies were made between September and June. This is the approximate hibernation period in Wyoming during which little change seems to take place in the reproductive structures. Most specimens were collected from a group of dens along Horse Creek on a ranch of the Warren Livestock Co., some 25 miles from Cheyenne, Wyoming. This group constitutes about 75 per cent of the specimens and is probably most significant in representing a fair sample of a large population. Collections were made in the spring as well as in the fall at these dens. The writer is greatly indebted to Mr. George Baxter, through whose efforts many of the specimens were collected.

## Ovarian Cycle

The size of the ovarian follicle in vertebrates generally has long been used for determining the more exact phase of the female sex cycle. In the immature rattler the individual follicles have dimensions of not more than 6 x 4 mm. As the animal matures they increase in weight over a hundredfold and attain a size of approximately 30 x 15 mm. In this condition the female ovulates in the early summer or late spring. The eggs are fertilized and a gestation period of several months follows. Immediately following ovluation the ruptured follicles are transformed into corpora lutea, while the next generation of egg follicles are not altered and do not exceed 6 mm. in length. The entire transformation of the ovary during gestation has been followed histologically in several other snakes and reveals no follicular growth during this period (Rahn, 1938, 1939). For the rattler the same thing has been observed. Thus, we see that the ovary is very suddenly transformed at the time of ovulation back into an immature appearing condition, except for the presence of the newly formed corpora lutea, one for each ovulated follicle. This concept is important, because at the time of parturition (August, September) and later in the winter and even the following spring the size of the follicles has not been noticeably altered. The corpus luteum begins to disintegrate about the time of parturition, yet remains of the yellow fat infiltrations into this degenerating body may often be recognized in such animals the following spring. Thus, one characteristic by which we may recognize an animal which has had a litter in the late summer is the small size of the ovarian follicles and the remains of corpora lutea. Such snakes will be referred to as post-partum females.

As these animals emerge from their dens during late May (Wyoming) their follicular size is still about 6 x 4 mm., similar to that of an immature animal. On the basis of an annual reproductive cycle, as Klauber (1936) believes occurs, these animals would have to increase their follicular size over a hundredfold, mate and ovulate within the next few weeks so that they might finish their long gestation period before the onset of fall. If, on the other hand, one assumes a two-year cycle, one can see how the ovary would grow during the whole summer and attain the large preovulatory condition by fall. All collections of mature specimens made during fall or spring show definitely two size differences in the ovary, the small post-partum ovary and the large follicle ovary of the "ripe" females (Fig. 1). These two types of individuals occur in more or less equal numbers. Theoretically, one might expect the "ripe" female category to be larger, since both immature and post-partum animals contribute to this classification, while only "ripe" animals contribute to the post-partum group (Fig. 2).

If the post-partum female attains the large, preovulatory condition of the ovary a year following her last litter, she enters hibernation and is ready for ovulation the following spring upon emerging from the den. In most Amphibia which ovulate in the spring the ovary attains a similar state of preovulatory condition in the fall, for they discharge their eggs soon after emerging from hibernation. So this concept of preovulatory readiness in snakes is not unusual except that the egg-layers have most of the spring and summer for restoration of the ovary, while the viviparous species in

the high altitudes with a short summer may have to pay for their specialization and skip every other year.

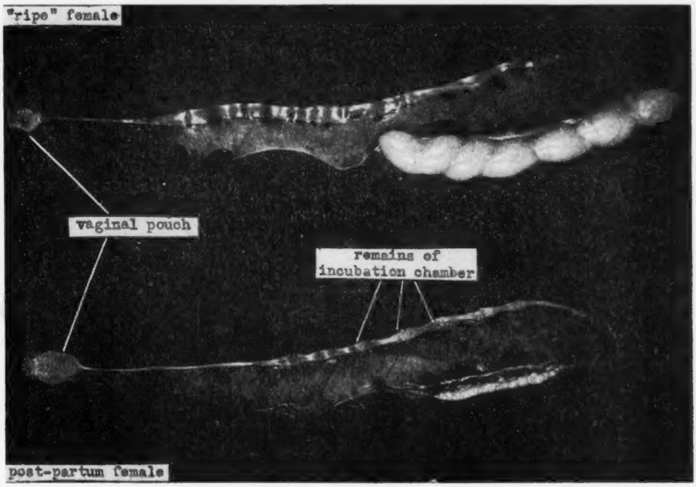


Fig. 1. The reproductive tracts (oviduct and ovary) of a typical "ripe" and a post-partum female dissected during April. Note especially the remains of seven incubation chambers in the uterus of the post-partum female. Furthermore the large vaginal pouches and the adjoining constrictions of the uterus can be seen. These, in the "ripe" females, store the sperm.

## Uterine Cycle

According to the comparative studies of Giersberg (1922), the oviduct in reptiles may be divided into the infundibulum, the tube, the uterus, and the vagina. The observations of this paper concern themselves primarily with the uterus, which receives and maintains the fertilized egg until it completes development. Consequently, this region becomes greatly modified and undergoes changes which are easily recognized for a considerable period following parturition.

Various experimental studies have shown that the size and differentiation of the reptilian oviduct depend upon the ovarian secretions or female sex hormones which in turn vary with the size and activity of the follicles. The immature uterus is approximately 2 mm. wide and very pale in appearance. As the ovary enlarges and finally attains maximal size the uterus becomes considerably larger, more coiled and measures now 5-8 mm. in width. Upon ovulation it receives the eggs and becomes enormously distended, especially so after the developing embryos enlarge due to the large water up-take. The regions of the uterus enveloping these embryos become highly vascularized; in some forms primitive placentae develop (Rahn, 1939) except in the regions of constriction which separate one embryo from another. The response in vascularity is not generalized for the uterus as a whole, but seems

to be restricted to the "incubation chambers" (Giacomini) where the uterus has become stretched to transparency. This structural modification is important for the recognition of post-partum animals, for the remains of the incubation chambers may still be recognized the following spring. They have not quite returned to their original shape, are still slightly stretched, and their great vascularity alternates with the anemic regions of constriction (Fig. 1). This typical post-partum condition is still evident in animals emerging from dens in May. The hyperemia gradually disappears and in "ripe" females with large ovaries it is no longer present. This change to the preovulatory condition is presumably accomplished during the summer following the last litter. By that fall the uterus is again smooth, i.e. without indications of the former incubatory chambers and hyperemia. From the gross appearance it seems to be ready to accommodate a new batch of eggs which are received the following spring.

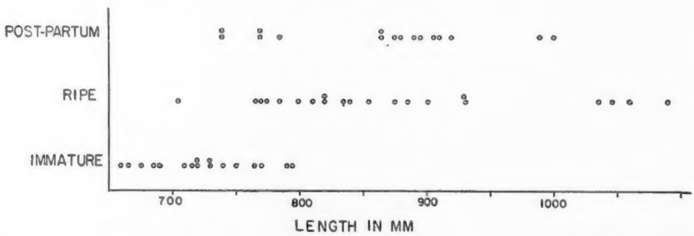


Fig. 2. Size distribution of immature, "ripe," and post-partum females autopsied during the hibernation period, September to June.

## Uterine Sperm

Finally, the absence or presence of motile sperm in the female reproductive tract remains to be considered. Direct observations of the sex ducts have shown that in *Thamnophis* sperm remain viable for several months (Rahn, 1940). Trapido (1940) has reported them in the fall for *Storeria* and observations on the isolated prairie rattler have shown that fall sperm retain their motility at least until the end of April. That not only the motility but also the fertilization capacity is retained for a considerable time in various snakes has been shown by Woodward (1933), Haines (1940), Kopstein (1938), Rahn (1940), and Blanchard and Blanchard (1940a, b). All these observations, especially those of Blanchard and Blanchard, indicate that delayed fertilization resulting from fall mating is probably a much more common phenomenon than has hitherto been realized.

Probably this is true for the prairie rattler also, since motile sperm survive in utero all winter. It was of extreme interest, consequently, to find that in all mature snakes collected in the spring and fall there was a definite correlation between the phase of the ovarian cycle and the presence or absence of sperm. All "ripe" females examined revealed the presence of motile sperm, while immature and post-partum snakes were without them. On the basis of what we know concerning the estrus period of mammals and birds, we might explain this correlation between the presence of sperm

and the ovarian condition by assuming that no estrus develops in a post-partum animal until the growth of the ovarian follicles is resumed simultaneously with the production of estrogens. Assuming a two-year cycle, this would then occur in the rattler the summer following her last litter when the ovary attains its large preovulatory size. Thus, the concept of summer or fall mating would fit rather well into this picture, since all "ripe" females investigated so far revealed sperm in the fall or winter. That this

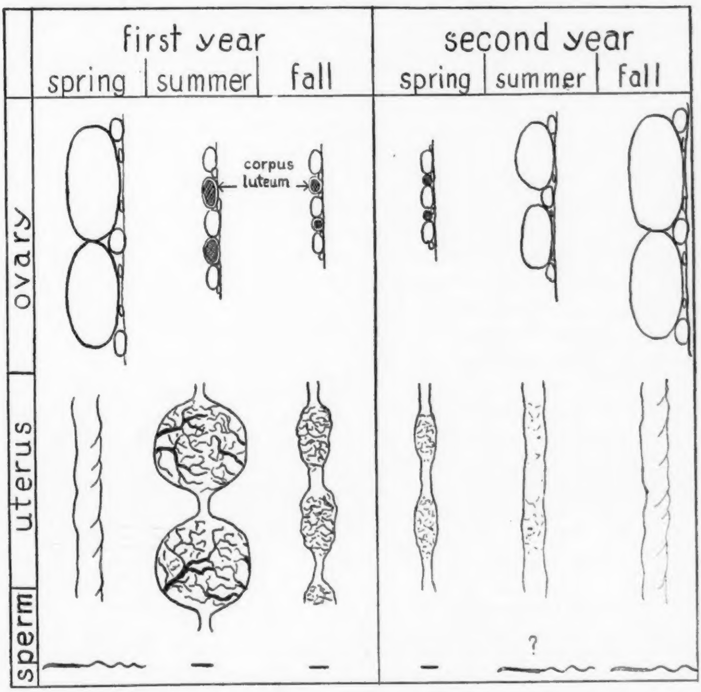


Fig. 3. Diagrammatic interpretation of the ovarian, uterine and sperm conditions during a two-year reproductive cycle of the female prairie rattler.

actually takes place seems so far only supported by one unpublished observation. Mr. A. M. Jackley, in charge of the rattlesnake control program of South Dakota, writes (*in litt.*) concerning *Crotalus v. viridis*: "it is a common experience for me to witness mating from the last days of August to about September tenth. This I have observed annually for almost twenty years." On the other hand Wood (1933) claims to have seen the mating of a pregnant female during the summer. This record is hard to explain with the present findings and assumptions.

The procedure for procuring sperm from the uterus by a long wire probe as previously reported had to be modified in the rattlesnake. While in the gartersnake the sperm seemed to be distributed widely within the duct, they

were confined in the rattler to the most posterior portion only. In fact, a probe could not be inserted far beyond the cloaca, due to an extremely narrow and coiled constriction which is found just above the vaginal portion. This latter region, a very much enlarged, muscular portion (Fig. 1), and the narrow tube anterior to it both contain seminal fluid. For reasons unknown the sperm seem to be confined and stored in this region all winter, since they have never been observed in the uterus proper until just prior to ovulation. The histology of this sperm storing region will be described in another communication (Ludwig and Rahn).

### Discussion

These data are presented for consideration and criticism. It seems that they can be most easily analyzed on the assumption of a two-year female reproductive cycle, as exhibited diagrammatically in Figure 3. If further work substantiates this theory it would not be surprising to find similar occurrences in other viviparous or ovoviviparous reptiles living in climatic conditions similar to the Wyoming plateau. On the other hand, animals found at progressively lower altitudes or farther south will have yearly cycles and even several ovulations per year in tropical zones. An analogous observation has been described by Wunderer (1910) for *Salamandra atra*: the gestation period for this viviparous animal varies from two to three years depending upon altitude.

The only other observations which are available on the reproductive cycle of this species of rattlesnake are those of Klauber (1936), who studied a large population of several hundred females at Platteville, Colorado, less than 100 miles from the Cheyenne, Wyoming, locality. Both places lie in the same drainage and there is little difference in altitude (5600 feet at Horse Creek; 4800 feet at Platteville). Small deviations might be expected between these two populations, yet not only do the Platteville snakes average about 100 mm. less in length,[1] but about 90 per cent of these females above 700 mm. are reported to be of the "ripe" (gravid) kind. Klauber thus justly assumes that "it is proven that young are borne annually." It is hard to explain such differences in the reproductive physiology of these two populations.

The recent reports of Blanchard and Blanchard (1940a, b) are also of great interest in this connection. Their breeding experiments on the gartersnake, *T. s. sirtalis*, have shown definitely that in the vicinity of Ann Arbor, Michigan, this viviparous species is capable of an annual reproductive cycle when kept in out-door pits. It might possibly be argued that their sheltered life and abundant food are sufficient to stimulate ovarian growth for an annual breeding cycle, while the wild specimens in less favorable conditions may not necessarily fare as well. It seems worthwhile to point out this fact in connection with 34 mature females of this same species collected from a den on Penekese Island off the south shore of Massachusetts. Of these only 14 were near ovulation or pregnant during June. The remainder represented various ovarian stages which averaged between one-quarter to one-eighth of the volume of the ripe follicle. It does not seem very likely

[1] This estimate is derived from measurements of 125 males and females from the Cheyenne locality.

that the latter would have ovulated and become pregnant that same summer, although many of them had living sperm in their uteri. Possibly the average climate of this general latitude is just critical for an annual reproductive cycle. In favorable surroundings (with high summer temperature and abundant food) the ovary may be able to build up to ovulation size every year, while less favorable circumstances necessitate an extra year.

## Summary

With the assumption of a two-year reproductive cycle in the prairie rattler of Wyoming, one can briefly summarize the phases as follows. The mature "ripe" female which is destined to ovulate in late spring is physiologically and morphologically nearly ready for this process in the preceding fall, judging by the large ovarian follicles, a large, smooth-appearing uterus, and the presence of motile sperm in the vaginal region. During hibernation little change takes place in the reproductive tract and upon emergence in the spring ovulation occurs. Prior to this event the sperm must have traveled to the upper region of the uterus. Since motile sperm are able to survive in utero all winter, it seems doubtful that an additional spring copulation is necessary for successful fertilization.

During the period of gestation the next generation of follicles remains inhibited and the corpora lutea develop in the ruptured follicles. With the exception of a slow degeneration of the corpora lutea following parturition, this condition seems to prevail until the following spring. Probably no copulation takes place until the summer or fall following parturition, when again the ovarian follicles attain their large preovulatory condition. At some period during this ovarian growth the animal will come into estrus and copulate, so that it starts out in the second fall fully equipped to produce another litter the succeeding spring.

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# The Cloaca of the Female *Amphiuma tridactylum*

By Florence Brooks Kreeger

AFTER it had been observed that the female *Amphiuma tridactylum* retained spermatozoa for several months, the cloaca was examined for presence of a sperm-storing organ and both a dorsal and a ventral spermatheca were discovered.[1] Available literature makes no reference to a ventral spermatheca in *Amphiuma* or any other salamanders, although a dorsal spermatheca has been reported in several members of the Caudata. The ventral sperm-storing organ of *Amphiuma* is in the same location as the "ventral gland" in the cloacas of several other salamanders. However, its tubules are identical in appearance to those of the dorsal spermatheca and spermatozoa were found in them.

Smears made from the cloacal walls of female *Amphiuma* in the spring and summer show active spermatozoa. One animal collected in New Orleans in March, 1940, for the Tulane University Zoology Department, showed spermatozoa at that time; and after being kept isolated from other *Amphiuma* she still showed active spermatozoa as late as October. Another animal caught and isolated in April, 1941, retained live spermatozoa until December. Thus spermatozoa introduced before capture may remain in the cloaca for at least seven or eight months.

[1] A dorsal spermatheca had previously been observed in *Amphiuma* by Professor Francis H. Wilson of Tulane University, who furnished the material for this study and whose invaluable aid is gratefully acknowledged.

Louise C. Baker (1937) reported spermatozoa in the cloacas of female *Amphiuma* from July to September, but she did not state whether these animals were kept in isolation.

### Cloacal Structure

Grossly and histologically, the cloaca of the female *Amphiuma* has a simpler structure than that of the male. Superficially almost identical with the male, the female cloacal aperture is a longitudinal slit bordered by thick folds or lips. Spreading these folds apart reveals the heavily pigmented interior of the posterior portion of the cloaca. This heavy pigmentation is the striking external differential character of the female, since the lateral walls of the posterior cloaca in the male are light gray or pinkish. Just inside the lips, and parallel to them, there is a row of tiny openings that can be seen with the naked eye.

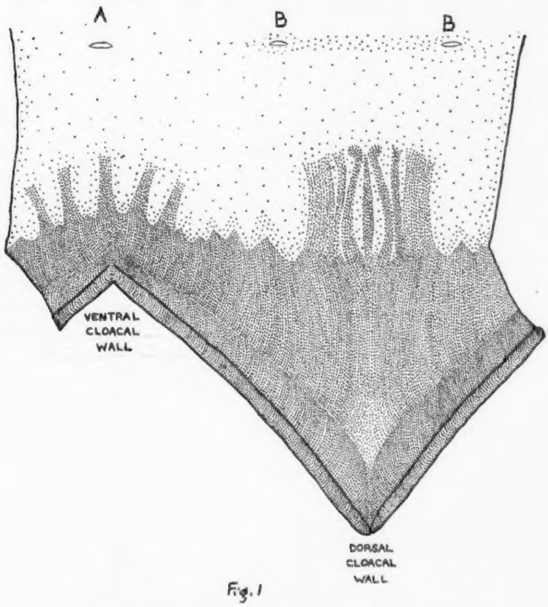



Figure 1. Semi-diagrammatic drawing of a dissection through lip of vent and lateral wall of tubular cloaca of female *Amphiuma*. Ventral wall of tubular cloaca on the left, bearing five pigmented ridges which mark the region of the ventral spermatheca. Pigment pattern on tubular portion of dorsal wall marks dorsal spermathecal region. A, opening of ureter; B, openings of oviducts.

Figure 2. Single spermathecal tubule showing bundle of spermatozoa typically oriented with heads toward blind end of tubule.

The posterior half of the female cloaca is a longitudinal groove, beginning ventrally at the posterior end of the vent and sloping dorsoanteriorly

to the anterior tubular half of the cloaca. Where the tubular portion begins, the pigment, characteristic of the groove, ends in a ragged line.

To complete the observations, some animals were killed and the cloacas opened by a cut made through the side of the cloaca, beginning near the anterior end of one lip and proceeding obliquely toward the pelvic limb of the same side, avoiding injury to the ventral region just anterior to the cloacal aperture. The incision was extended through the pelvic girdle, then turned sharply and continued transversely across the mid-line. The entire cloaca was laid open, pinned securely, and hardened in that position with formalin.

Such a preparation is shown in Figure 1, with the ventral portion of the cloaca and the anterior ends of the lips shown on the left, and the dorsal region and posterior end of the lips shown on the right. The pigmented lateral walls of the posterior groove, which are normally thrown into shallow folds, now appear almost smooth, being somewhat stretched, and form a large triangular area with its apex the most posterior point of the vent.

Anterior to the posterior black triangle, in the sparsely pigmented tubular cloaca, is a small area, roughly lyre-shaped, bearing five pigmented ridges. The three central ridges are narrow, the two lateral ones broad, and all merge at the base or posterior end of the area. These ridges assume patterns that vary with individuals. This is the site of the dorsal spermatheca.

A short distance anterior to the spermatheca, the openings of the oviducts occur laterally on the dorsal surface. Immediately anterior to these openings, but not shown on the figure, a transverse ridge marks the transition to the rectum. On the ventral portion of the cloaca, to the left in Figure 1, can be seen the anterior ends of the lips, the five short ray-like pigmented ridges marking the area of the ventral spermatheca, and anterior to them the opening of the bladder medially at about the same level as the oviduct openings.

When finally the entire cloacal region was dissected out for sectioning the posterior ends of the mesonephroi, which had been left attached, were found to extend caudally along the dorsal wall just under the spermatheca.

## Histology of the Cloaca

The epithelium covering the lips of the cloaca differs from the outer skin chiefly in the absence of typical skin glands. There is a gradual thinning of the epithelium from the lips to the lateral walls of the cloaca. The surface cells of lips and cloacal wall are squamous; the underlying cells are chiefly cuboidal but there are many very tall cells with long oval nuclei in the basal layer of the epithelium. There is a layer of pigment cells in the connective tissue and scattered pigment deeper in the connective tissue and among the epithelial cells.

The most abrupt change in the character of the epithelium occurs near the posterior edge of the spermatheca. The number of layers increases and squamous cells are no longer present, the superficial ones being cuboidal. The stratified cuboidal epithelium scarcely begins when there is another abrupt transition to glandular surface cells still underlaid for a short distance by stratified cuboidal cells three or four layers deep. The secreting

cells are large and plump with small basally located nuclei. Among the larger cells are scattered tall thin cells with large elongated nuclei and granular cytoplasm. These are evidently in another stage of activity. In the large cells the secretion stains bluish purple with Delafield's; the small nuclei appear dark purple. In the tall thin cells, the granular cytoplasm stains bright orange with orange G. The secreting type of simple columnar

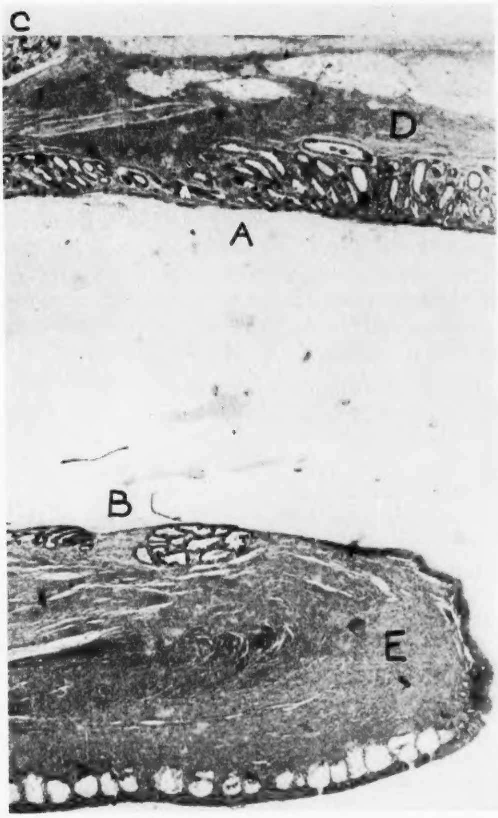


Figure 3. Sagittal section through cloaca of female *Amphiuma*. A, dorsal spermathecal tubules. B, tubules of ventral spermatheca. C, mesonephros. D, dorsal wall of cloaca. E, lip of ventral tubular cloaca.

epithelium continues over both the spermathecal areas and throughout the tubular part of the cloaca to the rectum.

The small openings mentioned in the general description as running parallel to the lips were found on histological examination to be small blind pits in the epithelium.

### The Spermathecae

The spermathecae consist of numerous short, saccular tubules opening separately on the dorsal and ventral pigmented areas previously described. The dorsal spermatheca occurs in the region occupied in the male by the anterior pelvic gland (Fig. 2, A). The ventral spermatheca tubules occupy the region which, in the male, contains the ventral portion of the cloacal gland (Fig. 2, B). Their general tendency is to curve anteriorly and laterad from their openings.

Figure 3 represents a single tubule in tangential section with a group of spermatozoa characteristically arranged in a bundle with heads pointing toward the blind end of the tubule. Where sperms were found in the tubules this was the usual arrangement. The epithelium of the tubules is for the most part simple cuboidal but varies from almost flat cells to low columnar, the columnar cells usually having a very ragged or uneven surface.

Not only does the variation in shape occur throughout the tubules, but even in a single tubule there can sometimes be found a complete range from flat to columnar cells resulting in an uneven surface within the tubule. The nuclei of the epithelial cells are proportionately quite large. When stained with Delafield's and orange G, the nuclei appear dark purple and the cytoplasm a clear pink or orange. A stringy secretion can be observed in many of the tubules with or without sperms.

### Other Histological Aspects of the Cloaca

The spermathecal tubules are imbedded in a mass of rather dense connective tissue which extends anteriorly and posteriorly as the connective tissue underlying the epithelium, dorsally to surround the tip of the mesonephros which lies dorsoanteriorly to the spermatheca (Fig. 2, C). Dorsal to this dense connective tissue and posterior to the end of the mesonephros are two extensive fatty areas separated by thin sheets of connective tissue. At some distance posterior to the spermatheca in the region dorsal to the posterior ends of the cloacal lips is found a small group of gland tubules. These tubules, occurring in the connective tissue layer and the fat adjacent to it, appear to be non-functional and are possibly rudimentary abdominal glands. No other dorsal glands could be found and no ventral glands other than the ventral spermatheca.

### Discussion

The striking peculiarity of the cloaca of the female *Amphiuma* is the occurrence of a ventral as well as a dorsal spermatheca. The ventral spermatheca consists of fewer tubules than the dorsal (Fig. 2) and during the fall and winter months, when the dorsal organ may contain few spermatozoa, the ventral tubules may show none. A ventral sperm-storing organ was not described by Kingsbury, Dieckmann or Koehring for any of the animals they studied; nor does Noble refer to such a structure in the salamander cloaca. In *Amphiuma* the ventral spermatheca occupies approximately the region of the ventral gland described for *Triturus, Necturus, Ambystoma, Eurycea* and *Gyrinophilus*. The location indicates a modification of the ventral gland into a sperm-storing organ. A possible homology to the ventral part of the cloacal gland of the male *Amphiuma* is also suggested. The

dorsal spermatheca appears to be homologous to the anterior pelvic gland of the male.

The finding of spermathecae in *Amphiuma* removes any doubt that there is internal fertilization. Davison was not aware of the existence of this organ; he described certain capillary tubes opening alongside the lips of the vent and running into the tubular part of the cloaca. No trace could be found of these capillaries on sectioning the cloaca. Previously mentioned in this paper were certain pits occurring in a row parallel to the cloacal lips. It is possible these pits, associated with folds in the walls of the cloaca, were considered by Davison to be capillaries.

*Amphiuma* closely resembles *Triturus, Salamandra, Necturus* and *Ambystoma* in respect to the spermathecal character, since it has merely an aggregation of numerous short, simple tubules opening separately. Unlike *Ambystoma,* its spermathecal tubules do not appear to be highly secretory. In *Ambystoma* and others, the tubules open in a depression while in *Amphiuma* they open directly on the surface of the cloaca. Probably no great importance can be attached to this difference, since the *Amphiuma* cloaca was opened while fresh and fixed in the position most advantageous for observation. This method removed temporary folds and grooves. All the other cloacas previously described were fixed in a folded and contracted condition which may have been further emphasized by the slight shrinkage accompanying fixation.

There is an obviously great difference between the extremely simple spermathecae of *Amphiuma* and the highly modified organ found in *Eurycea, Gyrinophilus, Plethodon* and *Desmognathus,* which consists in general of a few tubules compactly arranged and opening by one or two central tubules.

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# The Source of the Blood Ejected from the Eye by Horned Toads

By Gretchen Lyon Burleson

THE remarkable phenomenon of ejection of blood from the eye by some horned lizards (especially *Phrynosoma blainvillii*) has often been described and is usually termed a defense mechanism. The literature, thus far, does not offer a satisfactory explanation as to the nature of the discharge from the eye, nor an adequate explanation for its function. The source and mechanism of the ejection seems to have been partially determined by H. L. Bruner (1907).

Bruner describes a large sinus orbitalis in lizards, which occupies the space between the eyeball and the orbital walls and surrounds any structures therein, such as the lacrimal and Harderian glands. This sinus follows the M. depressor palpebrae inferioris muscle into the lower eyelid and, in the anterior region of the orbit, reaches into the nictitating membrane, there to connect with the small sinus of that membrane. Into the sinus orbitalis, which covers most of the medial surface of the eyeball, are discharged nearly all of the veins from the anterior portion of the head.

Bruner theorizes that a rise of blood pressure in the sinus orbitalis might contribute to an explanation of the blood ejecting phenomenon of the horned lizard, and this supposition led to his investigation of the "swell mechanism." The blood pressure had to be increased in some fashion and his discovery of a special muscle that obstructs the internal jugular vein appeared to furnish the necessary mechanism to raise this pressure. Bruner postulates that this special muscle, the M. constrictor venae jugularis internae, along with the M. protrusor oculi, and aided by the smooth muscles of the orbit, might contribute sufficient power to bring about an ejection. The remarkable distance to which the blood may be ejected entails considerable force and it is questionable, therefore, whether the problem is completely solved. It hardly seems possible, for instance, that an original pressure far back in the swell mechanism and eye muscles, can be sufficient to force a stream of blood a reported 6 feet (Holder, 1901) and an observed distance of 3 feet. Also, since this mechanism is found in lizards other than the horned lizard, it can not be considered as having been designed exclusively for the purpose of ejecting a stream of blood.

Bruner produced an ejection by *Phrynosoma* experimentally by the compression of the two venae jugularis internae and an elevation of the upper eyelid. Upon examination of microscopic sections from the region of the eye of this animal, he discovered that the blood had escaped from the nictitating membrane, which was forced outward by the high blood pressure in the sinus orbitalis. The outer wall of the blood sinus in the membrane was ruptured while releasing the flow. He advances the question as to whether the location of the opening is the same under natural conditions.

In the presence of a dog, horned lizards may be excited into an ejection

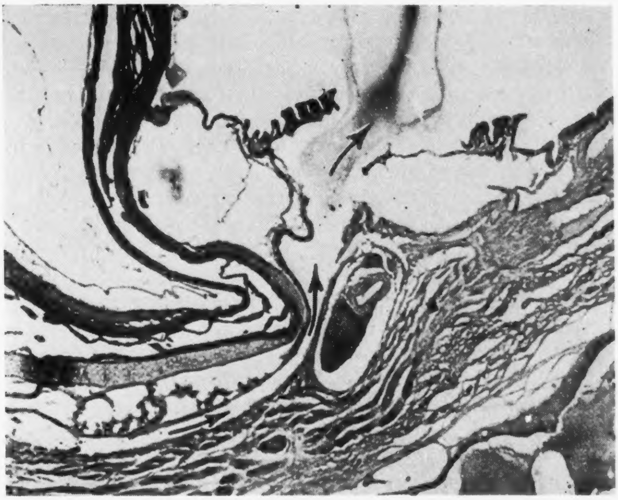

**Fig. 1.** Left eye of *Phrynosoma;* section through rupture from sinus orbitalis into conjunctival sac. Arrows indicate course of blood.

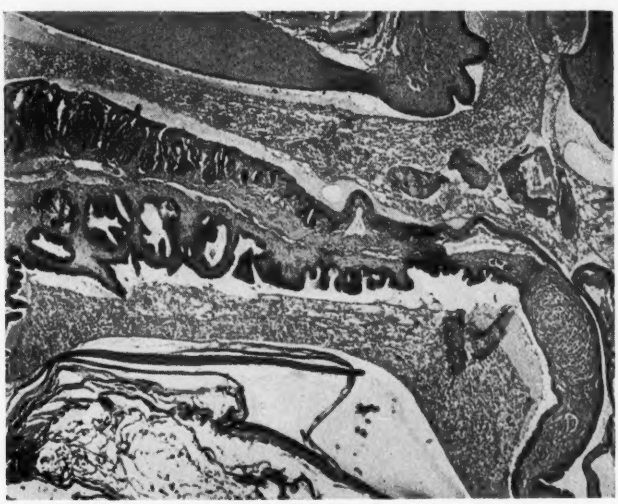

**Fig. 2.** Right eye of *Phrynosoma;* section through blood-flooded conjunctival sac in vicinity of lacrimal duct (upper portion), Harderian duct (lower portion) and nictitating membrane (lower right). Mass of blood in upper right corner indicates passage to exterior between eyelids.

and in this manner natural ejections were obtained in two specimens. In one of the animals the left eye spurted blood for a distance of nearly 3 feet, while the right eye produced only a slight discharge. The heads of the animals were immediately fixed and fifteen micra sections made of the entire eye region. A condition radically different from that presented by Bruner has been observed in both specimens. The blood had its source in the sinus orbitalis, but, instead of rupturing the nictitating membrane, had forced a passage through the ventral wall of the conjunctival sac. The rupture is seen clearly on the slides to have received its supply of blood from a ventral extension penetrating the lower eyelid, and not directly from the sinus orbitalis. Small quantities of blood cells may be found scattered along this passage, although most of the blood that had rushed into the conjunctival sac apparently had been forced to the exterior at the time of ejection, and the conjunctival sac was practically empty of blood. The right eye of this same animal had released some blood, which oozed out between the closed eyelids. The fluid was not discharged with any force, and in sections of this eye the fact was noted that a large amount of blood remained lodged throughout the eye region, in the conjunctival sac, around the nictitating membrane, and in the ducts of the lacrimal and Harderian glands. Sufficient pressure obviously had not been reached to clear the entire system of blood.

Even though the source of blood in all cases has been the sinus orbitalis, there are at least two avenues of rupture into the conjunctival sac at the moment of an ejection.

The configuration of the lacrimal and Harderian glands makes it possible for their secretions to become mixed directly with the blood of the conjunctival sac before the fluid is ejected to the exterior. Whether these secretions have any relation to the apparent aversion demonstrated by some animals to a horned lizard's ejected blood is unknown, but the possibility is at present under investigation.

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# A New Snake of the Genus *Drymarchon* from the Tres Marias Islands[1]

By VERNON E. BROCK

THE revision of the Mexican forms of *Drymarchon* by Hobart Smith (1941) indicates that a large *Drymarchon* collected by the writer in the Tres Marias in 1940 represents an undescribed form. Dr. Smith notes that a Tres Marias specimen (referred to *rubidus*) had a greater number of ventrals and caudals than any mainland examples available to him, and he suggests that "if further specimens from the islands consistently have high counts, they should be recognizable as belonging to a different subspecies." The scale counts given by Smith for his snake, those of two Tres Marias specimens recorded by Boulenger (1894: 32), and those of the example at hand, make possible a comparison with the mainland snakes reported by Smith. It seems certain that the Tres Marias snakes form a distinctive population, which is here named.

*Drymarchon corais* **cleofae,** new subspecies

TYPE.—Standard Natural History Museum No. 9447, a male, collected on Maria Cleopha Island, Tres Marias group, Nayarit, Mexico, on February 24, 1940, by V. E. Brock.

DIAGNOSIS.—*Drymarchon corais cleofae* is similar to the mainland *D. c. rubidus* Smith, differing in the possession of a greater number of ventrals and caudals and a lesser number of infralabials. It is confined to the Tres Marias Islands, Nayarit, Mexico.

DESCRIPTION OF TYPE.—Supralabials eight, the sixth in contact with temporals; infralabials seven, last greatly reduced and hardly bordering mouth; four in contact with chin shields, three in contact with anterior chin shields; two preoculars on one side, one on other; two postoculars; temporals 2-2, possibly also a greatly reduced anterior third one; ventrals 206; anal entire; subcaudals 78/78 plus 1. Total length 1590 mm., tail 281 mm.

Nearly uniform black above with an occasional scale wholly or in part light. Top and sides of head black to below eye; upper and posterior part of supralabials black, remainder white, the white areas being largest in the posterior supralabials; infralabials with posterior black margins, remainder white; scales in gular region largely immaculate. Belly likewise immaculate anteriorly except for occasional black spots; tail and posterior part of belly uniformly black.

DISCUSSION.—Boulenger's two examples, both females, had the ventral/caudal counts 203/77 and 200/81. Smith's (U.S.N.M. 24683), a male from Maria Madre, is said by him to have 203/82, although Stejneger (1899: 70) gives 205 ventrals for the same specimen. I accept Smith's count for the sake of probable uniformity in counting all his sample of *rubidus*. Stanford Natural History Museum No. 9447, which keys down nicely to *rubidus* in

[1] I wish to thank Dr. George S. Myers and Mr. T. Paul Maslin for help and advice.

Smith's key, has 206/78. These counts of the ventrals of Tres Marias snakes may be compared with Smith's counts of 20 mainland ***rubidus,*** of which the highest count is 201 in a female (U.S.N.M. 5405 with incomplete tail from Puente de Ixtla, Morelos. Pertinent data on the mainland and island races are given herewith (Table I).

TABLE I

| Source of specimens | Tres Marias Islands | West Coast of Mexico |
|---|---|---|
| Mean no. of ventrals | 203.00 | 194.75 |
| Standard deviation | 2.121 | 2.998 |
| Number of specimens | 4 | 20 |
| Sex of specimens | 2 males—2 females | 11 males—8 females—1 ? |

Although the mean number of ventrals differs by two or three between the males and females of a sample, the proportion of the sexes is enough alike in the two samples so that sexual differences do not contribute significantly to the difference between samples. The two samples are small, especially that from the Tres Marias; however, a good estimation of the significance of the difference between the means of small samples, in terms of probabilities, may be obtained by the use of the "t test" (Simpson and Roe: 211). From this test, the probability that the difference between these two samples may be assigned to chance is less than one in ten thousand ($P. < .0001$). This is such a low probability that the difference in the number of ventrals between these two samples must be regarded as being highly significant, and on this basis the Tres Marias ***Drymarchon*** is distinctive from that occurring on the adjacent mainland.

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FISH COMMISSION OF OREGON, ASTORIA, OREGON.

# Effects of Crotalid Venom on North American Snakes

By Hugh L. Keegan and Ted F. Andrews[1]

ALTHOUGH the question of the susceptibility of snakes to their own venom, or to venom of other species, has been of interest for some time, relatively little experimental work has been undertaken in this field. Most reports in the literature cite examples in which one snake was seen to bite another. In some of these the bitten animal died, in others no effects were observed. It was not possible to estimate the amount of venom injected with such a bite. Gloyd (1933), Wooster (1933), and Conant (1934), have published such reports. On several occasions in the laboratory, the authors have seen poisonous snakes bite non-venomous species, with similarly varying results. The results of injection of measured amounts of the venoms of North American crotalids into 31 snakes, representing 20 species, from several regions of the United States, are here reported. Weir Mitchell (1861), and Nichol, Douglas and Peck (1933) have obtained evidence that several North American crotalids are not immune to their own venoms if sufficiently large quantities are injected. Noguchi (1904), found that the green snake *(Opheodrys vernalis)* showed almost no symptoms when given an injection of 5 mg. of *Crotalus* venom.

## Materials and Methods

Venoms used in this investigation were obtained from 5 adult timber rattlesnakes *(Crotalus horridus atricaudatus)*, one adult massasauga *(Sistrurus catenatus catenatus)*, and 4 adult copperhead snakes (*Agkistrodon mokasen cupreus)*.

The method of extracting and handling the venom was similar to that of Allen (1941). The dried, crystalline venom was stored at 5° C. until time for use. For purposes of injection, 5 per cent and 10 per cent solutions of venom in sterile normal saline were introduced into the dorsal trunk muscles. These solutions were made up immediately before the injections.

Whenever possible, snakes of the same species and size (adults if available) were given equal injections of each of the three types of venom, although lack of specimens prevented a complete series for most species. For *Natrix sipedon pictiventris, Crotalus horridus atricaudatus,* and *Agkistrodon mokasen cupreus* young snakes (3-4 mos.) that were born in the laboratory were used. Each snake was isolated after injection, and all but a few were kept at room temperature, 22° C., and observed continuously for several hours.

Before any injections of venom were made, specimens of *Natrix sipedon pictiventris, Charina bottae, Diadophis amabilis occidentalis* and *Coluber constrictor mormon* each received an injection of .1 cc. of sterile saline in the muscles of the dorsal body wall. No harmful effects were produced by these injections.

Each animal was autopsied immediately following death and a Kodachrome photograph was taken of the viscera.

[1] The authors wish to express their appreciation to Professor L. O. Nolf for helpful advice and criticism throughout the course of these experiments.

The injections made with each type of venom, the length and weight of each recipient, and amount of venom injected per gram body weight in each, are tabulated below with an indication as to whether the dosage was lethal, and the time elapsing between injection and death.

## Discussion

Immediate restlessness, swelling at the point of injection, and progressive lethargy were general reactions to the injections in specimens that died. Several of the snakes showed a tendency to lie belly up, and almost all gaped widely shortly before death. Dyspnea-like reactions were apparently due to the lungs becoming filled with blood. In a few instances, bleeding from the mouth occurred. The region of the body surrounding the injection site appeared to be paralyzed in some of the animals. This might indicate a neuro-toxic effect of the venom. Brown (1941) demonstrated a neuro-toxic action of water moccasin venom on dogs.

The venoms apparently have the same effects as on warm-blooded animals. Extensive ecchymosis, hemorrhage, and histolysis were general, varying only in degree. In some animals, the lung was found to be nearly filled with extravasated blood, and histolysis was evident surrounding the injection site, as well as in the region of the heart. Essex and Markowitz (1930) found a similar histolysis caused by *Crotalus* venom in perfused heart and lung preparations of the dog.

Results of our experiments indicate specific differences in resistance to the venoms. Specimens of *Diadophis amabilis occidentalis*, for example, died more quickly following injections of all types of venoms than snakes of other species receiving proportionate dosages. Snakes of this species showed signs of great distress almost immediately following injection of the venom, and autopsy revealed more extensive ecchymosis than in most other snakes.

On the other hand, a specimen of *Lampropeltis calligaster*, of approximately the same size as the *Diadophis*, survived an equivalent dose of *Agkistrodon* venom for five days. Although swelling and paralysis occurred, and the dermis was discolored and sloughed away from the body wall, ecchymosis was not as extensive as in most of the other snakes.

Such resistance might be expected from a member of this ophiophagous group, although observations of other species of *Lampropeltis*, as well as a large *Drymarchon* to which specimens of *Crotalus* and *Agkistrodon* were fed, indicate that success in overpowering and eating poisonous snakes may be due to ability to avoid bites rather than to an immunity. However, Rosenfeld and Glass (1940) demonstrated that the plasma of *Lampropeltis getulus getulus* had an inhibiting effect on the hemorrhagic action of the venoms of several vipers on mice.

It was found that young specimens of *Crotalus* were killed by both *Crotalus* and *Agkistrodon* venoms, and that a young *Agkistrodon* succumbed to an injection of *Agkistrodon* venom. Autopsy revealed that these snakes suffered the same effects as did the non-poisonous snakes. Reports by Mitchell (1861), Gloyd (1933), Wooster (1933), and Conant (1934), have indicated that rattlesnakes are not immune to their own venom.

Examination of the results given in Table I suggests a relationship

TABLE I

| RECIPIENT | LENGTH IN MM. | WEIGHT IN GRAMS | TYPE OF VENOM INJECTED | MILLIGRAMS INJECTED PER GRAM BODY WEIGHT | RESULTS |
|---|---|---|---|---|---|
| *Pituophis s. sayi* | 1054 | 244.1 | *Crotalus* | 0.0913 | Survived |
| *Pituophis c. catenifer* | 350 | 11.3 | *Agkistrodon* | 0.885 | Died 5.75 hours following injection |
| *Natrix s. sipedon* | 965 | 175.5 | *Agkistrodon* | 0.0684 | Survived |
| *Natrix s. pictiventris* | 876 | 182.5 | *Crotalus* | 0.122 | Died 48 hours following injection |
| *Natrix s. pictiventris* | 235 | 5.2 | *Crotalus* | 0.961 | Died 9 hours following injection |
| *Natrix s. pictiventris* | 229 | 3.6 | *Sistrurus* | 1.46 | Died 4.5 hours following injection |
| *Natrix s. pictiventris* | 250 | 6.5 | *Agkistrodon* | 0.769 | Died 10 hours following injection |
| *Natrix taxispilota* | 864 | 185.6 | *Agkistrodon* | 0.0808 | Survived |
| *Thamnophis s. sirtalis* | 635 | 42.9 | *Crotalus* | 0.233 | Survived |
| *Thamnophis s. sirtalis* | 1003 | 210.5 | *Agkistrodon* | 0.0713 | Survived |
| *Thamnophis s. infernalis* | 596 | 36.5 | *Crotalus* | 0.229 | Survived |
| *Thamnophis s. infernalis* | 558 | 28.9 | *Crotalus* | 0.449 | Survived |
| *Thamnophis radix* | 660 | 93.7 | *Sistrurus* | 0.074 | Survived |
| *Storeria dekayi* | 274 | 3.5 | *Agkistrodon* | 1.42 | Died 3.6 hours following injection |
| *Diadophis punctatus arnyi* | 308 | 4.1 | *Crotalus* | 1.22 | Died 3.18 hours following injection |
| *Diadophis p. arnyi* | 286 | 3.7 | *Agkistrodon* | 1.35 | Died 1.5 hours following injection |
| *Diadophis amabilis occidentalis* | 482 | 14.5 | *Sistrurus* | 0.179 | Died 4.5 hours following injection |
| *Diadophis a. occidentalis* | 458 | 12.8 | *Agkistrodon* | 0.781 | Died 3.3 hours following injection |
| *Diadophis a. occidentalis* | 495 | 15.2 | *Crotalus* | 0.657 | Died 3.1 hours following injection |
| *Contia tenuis* | 242 | 2.8 | *Agkistrodon* | 1.78 | Died 1.5 hours following injection |
| *Opheodrys vernalis* | 450 | 11.9 | *Agkistrodon* | 0.842 | Died 7.5 hours following injection |
| *Coluber constrictor flaviventris* | 330 | 6.1 | *Sistrurus* | 0.852 | Survived |
| *Coluber c. flaviventris* | 311 | 5.0 | *Agkistrodon* | 2.0 | Died 2.5 hours following injection |
| *Coluber c. mormon* | 304 | 5.4 | *Crotalus* | 0.925 | Died 36 hours following injection |
| *Charina bottae* | 250 | 9.7 | *Crotalus* | 0.515 | Died 6.5 hours following injection |
| *Charina bottae* | 244 | 8.8 | *Agkistrodon* | 1.13 | Died 2.3 hours following injection |
| *Lampropeltis calligaster* | 381 | 13.0 | *Agkistrodon* | 0.767 | Died 5 days following injection |
| *Heterodon contortrix* | 558 | 66.8 | *Crotalus* | 0.224 | Survived |
| *Crotalus horridus atricaudatus* | 356 | 19.4 | *Crotalus* | 0.515 | Died 24 hours following injection |
| *Crotalus h. atricaudatus* | 333 | 15.7 | *Agkistrodon* | 0.764 | Died 1.3 hours following injection |
| *Agkistrodon mokasen cupreus* | 256 | 8.3 | *Agkistrodon* | 1.20 | Died 2.3 hours following injection |

between the effect of the venom and the amount of the venom injected per gram body weight of the snake. Due to lack of specimens and venom, it was impossible to give proportionate doses to all snakes used. It was found, however, that only one of 21 snakes receiving more than 0.233 milligrams of venom per gram body weight survived. Also, only 2 of 10 snakes receiving less than 0.449 milligrams per gram body weight died. None of 5 snakes receiving less than 0.0913 grams per gram body weight died. These results indicate that some snakes had received sub-lethal dosages, as larger proportionate dosages proved fatal to other snakes. In some instances, in which species belonging to the same genus were given injections, the specimens receiving the smaller proportionate amounts of venom survived, and those receiving the larger proportionate amounts succumbed. This is especially conspicuous in the genus *Natrix,* of which specimens of widely varying sizes were used.

Nichol, Douglas and Peck (1933) obtained similar results in their work with the Texas diamond back rattlesnake, *Crotalus atrox.* They found that injections of less than 5 minims of venom were never fatal to the larger snakes, and that these snakes recovered, with only local swellings noticed. The weights of the individual specimens were not given in their report.

It appears that some venoms are more toxic than others in their effects on snakes. For example, a *Crotalus* receiving an injection of *Crotalus* venom died in 24 hours, while another of the same size, receiving an equal injection of *Agkistrodon* venom, died in 1.3 hours. Survival time after injection may presumably be considered a criterion in judging toxicity.

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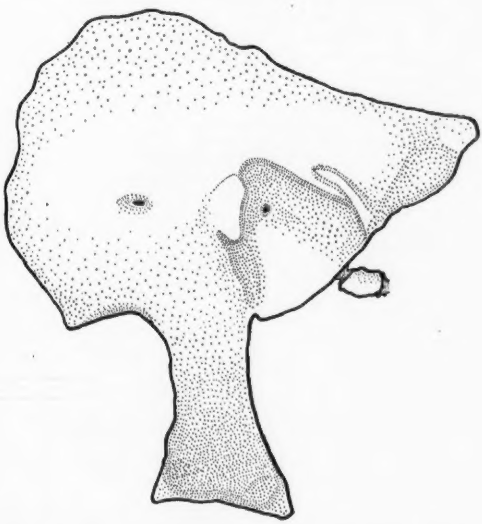
# Herpetological Notes

A SESAMOID ELEMENT IN THE SHOULDER REGION OF *AMBYSTOMA*.—In various species of ambystomids a small sesamoid element in the shoulder region appears to be consistently present. This element, the shape of a flattened ovoid, is located in the tendon of the coracoid head of the anconaeus muscle. Its lateral face is continuous with the surface of the capsule of the joint, and is flattened to provide a small area of articulation with the head of the humerus. The size is quite variable, to a large extent correlated with the size and age of the individual. In large adult *Ambystoma maculatum*, *A. tigrinum*, and *Siredon mexicanum* the length is approximately 1.5 mm. and the diameter slightly under 1.0 mm. In these specimens the element is separated from the cartilage of the girdle proper by a distance of 0.4 to 0.5 mm. In larvae and young adults the element consists of ordinary cartilage; in older specimens this cartilage is calcified, but microscopic examination shows no evidence of ossification.



The dried pectoral girdle of a 250 mm. neotenic *Ambystoma tigrinum mavortium* larva showing the element described. The position of the element is approximately the same as in life, though probably slightly altered by drying and shrinkage of the tendon. 9 × actual size.

The following forms have been examined and the cartilage found to be present: *Ambystoma tigrinum mavortium*, *A. maculatum*, *A. jeffersonianum*, *A. texanum*, *A. gracile*, *A. opacum*, *A. annulatum*, *Siredon mexicanum*, *S. lermaensis*, *Rhyacosiredon rivularis*, and a larva of an unknown Mexican species apparently related to *A. tigrinum*. Three specimens of *Dicamptodon* and two of *Rhyacotriton* were dissected and this element not found. It was likewise absent in all members of other families which were examined; these included *Triturus v. viridescens*, *T. granulosus*, *Gyrinophilus p. porphyriticus*, *Plethodon glutinosus*, *Desmognathus f. fuscus*, *Hynobius nebulosus*, and *H. chinensis*. Despite the rather extensive anatomical studies which have been made on certain salamanders, such as *Necturus* and *Salamandra*, I have not been able to find in the literature any reference to such an element in any salamander. It therefore seems probable that it is confined to the genera *Ambystoma*, *Siredon*, *Rhyacosiredon*, and, by inference only, *Bathysiredon*, and is of universal occurrence in these genera. Evidence as to its presence or absence

in other genera of Hynobiidae might be of particular interest bevause of the supposed rather close relationship between this family and the Ambystomidae.

That this is a sesamoid element rather than a vestige of some element of the primitive amphibian girdle is assumed because of its position within a tendon and because its location in relation to the coracoid and scapula makes homology with any such element appear unlikely.—J. A. TIHEN, *Department of Biology, University of Rochester, Rochester, New York.*

AN OLDER NAME FOR A RECENTLY DESCRIBED SALAMANDER.—In 1860, S. F. Baird (Report upon the reptiles collected on the survey by J. G. Cooper, M.D., *in* Rep't. of Explorations and Surveys . . . Miss. River to the Pacific Ocean, 12, book 2: 292–306, pls. 12–16, 19–22, 29, 31) briefly described a salamander collected by George Suckley along the Pacific Survey Route between Fort Union and Fort Benton, localities now in northeastern Montana but at that time in the Territory of Nebraska. This salamander was described as a "well marked variety, *melanosticta*," of *Siredon lichenoides* and was distinguished from typical *lichenoides* by its "fuller form, and in the presence of distinct rounded spots on a grayish brown ground, the spots larger and more distinct than in *S. mexicanus*." The length of the specimen was given as about 9 inches.

While no figure of this particular specimen was presented, reference was made to a figure of *Siredon lichenoides* in volume 10 of the Pacific Survey reports, plate 44, figure 1 (Report upon reptiles collected on the survey by S. F. Baird, *in* Rep't of Explorations and Surveys . . . Miss. River to the Pacific Ocean, 10, 1859: 9–13, pls. 11, 28, 30, 44). From this figure, from the size of the specimen and from the description, it is perfectly evident that Baird was dealing with a larval specimen of *Ambystoma*, and it remains to be determined whether he described a form which has remained unrecognized or one which has since been described under another name.

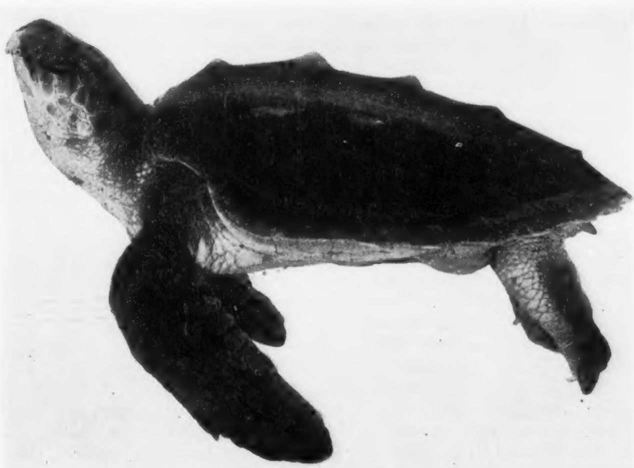
Suckley's specimen was assigned the number 4073 but, I have been informed by Dr. Doris Cochran, it is no longer to be found in the collections of the U. S. National Museum. There is, however, an adult *Ambystoma tigrinum* from Fort Union, Montana (USNM No. 14, 487), and, although in poor condition, its general pattern may be made out without difficulty. This specimen undoubtedly represents the subspecies *slateri* recently described by Dunn (1940, COPEIA (3): 159). The diagnosis of *slateri* is based on the adult animals and we must, therefore, examine larvae for comparison with the description of *melanosticta*. I have examined larvae from Montana and elsewhere determined by Dunn as *slateri* and among the several lots are many individuals with rounded black spots on a lighter ground. Larval *slateri* attains a length of at least 225 mm. (8⅞ inches), a size comparable to that of the specimen described by Baird. Since no other *Ambystoma* is known from northeastern Montana, one is forced to the belief that Dunn's *slateri* is the same as Baird's *melanosticta*, described eighty years earlier. The name of this subspecies should therefore stand as *Ambystoma tigrinum melanostictum* (Baird).—S. C. BISHOP, *Department of Zoology, University of Rochester, Rochester, New York.*

REMARKS ON THE NASAL PIT IN SNAKES.—In a recent number of COPEIA (No. 1, 1942) Mr. P. T. Maslin has given characters for the separation of the crotalid genera *Trimeresurus* and *Bothrops*. Of the five characters he lists, only the first one, namely the small pit in the nostril, can be regarded as of generic value. He states that it is present in all except two of the Asiatic species but is absent in the American species. This is not correct. Not only is the pit present in all the American species, but it is present, as far as I am aware, in every snake. It is connected with a structure that for want of an available name I have called the nasal pad. The pit is formed by an invagination of the epithelium covering the pad and leads into a more or less distinct cavity. What the function of the cavity is, I do not know; possibly it is a vestigial structure. The opening into the cavity varies both in shape and size, but this is partly dependent upon the method of preservation of the specimen. In the Homalopsinae and the sea-snakes the pad is modified. It is composed of dense spongy tissue and is distensible, thus forming a valve to prevent the entrance of water. In the sea-snakes the pad differs further from that of other snakes in being placed at the anterior margin of the nostril instead of the posterior.—MALCOLM A. SMITH, *British Museum (Natural History), London, England.*

NEW RECORDS FOR RIDLEYS.—Many years ago I often heard from Samuel Garman the story of how Mr. Kemp in Key West sent him the specimens which served as types for the sea turtle which he called by Kemp's name. Garman was told that it was locally known as the "Bastard Loggerhead" and that the conchs living in the Keys believed it to be a hybrid between the loggerhead and the green turtle.

Recently Archie Carr, working here in Cambridge, has added a considerable amount of information not previously known concerning this turtle and its relationships. Curiously enough Carr had no sooner returned to Florida when additional information began to appear.

Fussing around one afternoon in the Museum of Natural History in Boston I found, among a miscellaneous lot of odds and ends which were kept for lending to public school classes, what I thought was an odd looking sea turtle. I brushed it off and carried it to Cambridge and, lo and behold, it was a ridley, as we have now come to call this species, and a nice convenient name it is too, as well as one which is in actual use where the animal is obtained. The name "Bastard Loggerhead" is not now in use and probably never was. This turtle is well mounted by S. F. Denton of Wellesley, who was a good taxidermist. He got it from some fishermen who found it washed ashore either dying or just dead on the beach at No-Man's-Land. This was in March, 1903. I suspect that this turtle had been numbed by getting out of the Gulf Stream into cold water.



Now a few days ago, two boys walked into my office with a little sea turtle vigorously flapping its fins. They had bought it for a small sum at a water front fish market in Boston as a speculation. They made a good profit on their buy. Since the local fishing boats are afraid of submarines—with good reason—their fishing area is limited to parts of Massachusetts Bay just outside of Boston Harbor and it is from here that this little ridley must have come. We had been having strong southeasterly winds for a number of days and indeed on two of these the surf piled very high and there had very obviously been a heavy blow off shore. This pushed a big body of warm water into Massachusetts Bay, of which I had already heard. My children bathe regularly at Beverly Farms where I live in the summer and it was just after there having been talk of this warm water that the ridley appeared. It is just 2 inches larger than the one which Carr found in our collection (M.C.Z. 1406) from the Tortugas. Until he found it, its existence had been unknown.

We know from Carr's studies that even young specimens of this species are nervous, vicious, and irascible, fairly worrying themselves to death when they are taken out of

the water, in the South. This little fellow was as mild as milk, which I suspect was due to the fact that our coastal water seemed warmer to us than it did to him.

The length of the carapace of the No-Man's-Land specimen was 12 inches. The Boston Harbor example is 9.5 inches in length of carapace and 9 inches in width. It now bears the M.C.Z. number of 46537.

Since Doctor Carr has recently published an excellent dorsal view of a specimen of this species I am presenting here a photograph, by Mr. Nelson of this Museum, showing the creature in profile. Note especially the conspicuous hooked claw on the hind limb.—T. BARBOUR, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

STATUS OF THE NAME *CROTALUS CONCOLOR*.—The name *Crotalus concolor* Woodbury, the yellow rattlesnake of the Stejneger and Barbour *Check List of North American Amphibians and Reptiles*, was placed in the synonomy of *Crotalus viridis decolor* Klauber by H. K. Gloyd in his account of the rattlesnakes (1940, Spec. Publ. Chicago Acad. Sci., 4: 216). Gloyd explains his relegation of *concolor* to synonomy on the ground that it is "preoccupied by *concolor* Jan (1859, Rev. Mag. Zool., (2) 10: 153), a *nomen nudum* which originally appeared as a variety of *C. durissus* [*horridus*], and was later placed in the synonomy of *C. horridus* by Garman (1883, Mem. Mus. Comp. Zool., 8: 175) and by Stejneger (1895, Am. Rep. U. S. Nat. Mus., 1893: 427). Although the 'Munich' specimens on which it was based cannot now be found, according to a letter from Dr. Lorenz Müller, the association of Jan's name with *C. horridus* by subsequent reviewers of the genus gives it status as a synonym of that species, and *concolor* Woodbury (1929) is therefore a homonym." In the Field Book of Snakes (Schmidt and Davis, 1941: 310) the authors follow Gloyd in using *decolor* instead of *concolor*.

The writer has discussed this problem with Dr. Leonhard Stejneger, of the U. S. National Museum, who now informs me that he and Dr. Barbour conclude that in accordance with the International Rules, *Crotalus viridis concolor* Woodbury must be regarded as valid. He states that neither he nor Garman had any intention of validating Jan's *nomen nudum* by the simple expedient of citing his reference with a question of its relationship.

There seems to be no question that Jan's *concolor* was a *nomen nudum* and therefore it is "stillborn" and cannot be recognized under Article 25 of the International Rules.

Opinion 5 of the International Commission, which considers a case with a similar principle, and which holds that a "name, ineligible because of its publication prior to 1758, does not become eligible simply by being cited . . .", could well be interpreted to apply to any ineligible name such as Jan's. The fact that Garman and Stejneger each cited it could not possibly validate it unless one of them complied with the requirements of Article 25 (which neither one did), in which event, he, not Jan, would have to be cited as the author. The name *concolor* for the yellow rattlesnake accordingly cannot be rejected as a homonym of *concolor* Jan, Garman, or Stejneger, because this never had any validity under the International Rules. The question of whether Jan had a specimen that could be identified or not has no bearing on the case.—A. M. WOODBURY, *University of Utah, Salt Lake City, Utah.*

A VERY LARGE RED-BACKED SALAMANDER.—At the January, 1942, meeting of Staten Island Nature Club, the writer exhibited a very large red-backed salamander, *Plethodon cinereus*, 122 mm. (4 13/16 inches) in length. The salamander, which was alive when found by John Goetz on January 2, was probably dislodged by the heavy rain of the morning of that day. It was on top of the wall where bordered by grass along Stuyvesant Place, Staten Island, New York.

Jordan's *Manual of the Vertebrate Animals of the Northeastern United States* gives the length of this species as 3½ inches, and Dunn (1926, Salamanders of the family Plethodontidae: 166) records an adult female 88 mm. in length, without mentioning a maximum size. In the recently published *Salamanders of New York*, by Dr. Sherman C. Bishop, a large specimen, 91 mm. long, is reported from Rochester. Larger specimens south of Rochester may be expected, but one 122 mm. in length appears worthy of record.—WILLIAM T. DAVIS, *Staten Island Institute of Arts and Sciences, Staten Island, New York.*

ADDITIONAL NOTES ON *RANA SEVOSA*.—At the time of publication of our description of *Rana sevosa* (1940, Ann. Carnegie Mus., 28: 137–168) we had not seen any Alabama specimens of this species, but we referred Löding's record (1922, Alabama Mus. Nat. Hist., paper no. 5: 20) of *Rana areolata* from Dog River, Mobile County, to the synonymy of *sevosa*, on grounds of geographic probability. The apparent correctness of this action was confirmed by Mr. Löding, who wrote under date of February 12, 1941, as follows:

> There can be no doubt that the Rana sevosa described is the same thing as the three frogs I took years ago under drift logs on the beach of Mobile Bay just south of the mouth of Dog River, and which I identified as *areolata* from Dickerson's Frog Book; later Hurter agreed that while it differed in some respects from *areolata* as he knew it from Missouri it must be that species. The triangular head, dorsal warts, and color agrees entirely with your description and the plate is a dead ringer of these specimens. This frog must be very secretive for I have never seen specimens since, but Viosca identified the sound of what he called *aesopus* from a swamp in the same neighborhood. Two of the specimens in the Chas. Mohr Museum were lost some years after, but if I remember right, Hurter got the third one.

Mr. R. W. McFarland, of Fairhope, Alabama, recently sent us, for determination, a gopher frog (Alabama Museum of Herpetology No. 218), which he collected on the evening of June 2, 1941, as it was hopping across a road, 8 miles southeast of Fairhope, Baldwin County, Alabama. This specimen is clearly referable to *sevosa,* and thus constitutes the first record of the species east of Mobile Bay. It is an adult female, 99 mm. in snout-to-vent length, and the largest known *sevosa:* the maximum size of 29 Mississippi females, previously reported, was 92.5 mm. It agrees with typical *sevosa* in morphology and in ventral markings, but differs somewhat in dorsal pattern; the ground color is lighter gray, and the dark spots superimposed upon it are somewhat larger and less numerous than in most *sevosa.* This variation probably indicates only that *sevosa* is variable in number and size of dorsal spots, as are other representatives of the *areolata* group. It is possible that the atypical dorsal pattern of this specimen may indicate some *capito* tendencies in the population east of Mobile Bay, and that *sevosa* and *capito* may be found to intergrade somewhere in the area between Baldwin County, Alabama, and Berrien County, Georgia, although no gopher frogs are as yet known from that region.

Upon the basis of its structure and relationships we postulated (*op. cit.*: 154) that *sevosa* was both batrachophagous and insectivorous. The latter of these suppositions has now been confirmed, for Mr. McFarland's specimen contained the remains of three large beetles; namely, a carabid of the genus *Pasimachus,* and two scarabaeids belonging to the genera *Canthon* and *Ligryus.*

At the Gainesville meeting of the Society, Mr. Percy Viosca, Jr. exhibited two *sevosa,* an adult collected at Pearl River, St. Tammany Parish, Louisiana, on December 29, 1936, and a juvenile collected "ten miles out of Picayune, Mississippi" (Pearl River Co.?) in August, 1935. These specimens provide two additional localities for the species.—M. GRAHAM NETTING and COLEMAN J. GOIN, *Carnegie Museum, Pittsburgh, Pennsylvania, and University of Florida, Gainesville, Florida.*

A NOTE ON TWO MEXICAN SPECIES OF *GEOPHIS*—Since *Geophis sallaei* was originally described by Boulenger (Cat. Snakes Brit. Mus., 2, 1894: 318, pl. 16, fig. 1), on the basis of three specimens collected by Sallé at some unknown locality in Mexico, no further specimens have been recorded and the species has remained without indication of its distribution in Mexico. Accordingly the four specimens collected for the American Museum of Natural History (Nos. 19630–3) by Paul D. R. Rüthling are of more than casual interest. Thanks to Mr. C. M. Bogert I have been able to examine these and record certain data on them. They were collected at Cafetal Alemania, near Pluma Hidalgo, Oaxaca. In most details of scutellation they agree with the description given by Boulenger for the types. The scales are in 15 rows in all; the ventrals 118♂, 125♂,125♂, ? ♀; subcaudals ?, 36, 33, 29 respectively; supralabials 5-5 in one, 6-6 in others; infralabials 6-7 in three, 7-7 in one; postoculars 1-1 in all; no anterior temporal; all dorsal scales except those on anterior part of body weakly keeled.

Through the courtesy of Dr. Norman Hartweg, three specimens of the recently described *Geophis semiannulatus* (Smith, Proc. N. Engl. Zool. Club, 18, 1941: 49–51) in the Museum of Zoology, University of Michigan (Nos. 47805, 56479, 67650), have been examined. The most remarkable fact concerning them is that they are from Guerrero,

Hidalgo (collected by William Mann). Since Mexican *Geophis* species are notoriously restricted in distribution, considerable doubt is thrown upon the locality datum accompanying the type of *semiannulatus,* which was purchased from G. Glückert in 1913, and said to have been collected in Colima. It is not impossible that the species occurs in both localities, but it seems improbable; and the most reliable data are, of course, those for the specimens secured by Mann, who collected extensively at the town of Guerrero, Hidalgo, and at nearby localities.

In the three specimens of *semiannulatus* the scale rows are uniformly 17; the ventrals 163♂, 178♀, 181♀; caudals 40, 37, 37, respectively; supralabials 6-6 in all, the 5th largest and longest; 7-7 infralabials, 0-0 preoculars, 1-1 postoculars, and 1-2 temporals in all; bands on body and tail 38-11, 43-9, 37-7, respectively. The bands are somewhat irregular, and most of them involve the ends of the ventrals. Otherwise these specimens are marked like the type.—Hobart M. Smith, *Department of Biology, University of Rochester, Rochester, New York.*

NOTES ON *TRIMERESURUS NIGROVIRIDIS MARCHI.*—A shipment of ten Honduran palm vipers (*Trimeresurus nigroviridis marchi* Barbour and Loveridge) was received at the Chicago Zoological Park on March 16, 1940. These specimens were collected by R. E. Stadelman at Portillo Grande, Yoro, Honduras. They varied from about 450 mm. to 882 mm. in length. The ventrals and caudals are a little more numerous than those recorded by Barbour and Loveridge in their description of this form, ranging from 168 to 171 and from 62 to 69 in four males, and from 160 to 172 and from 50 to 61 in six females. The dorsal scale count is 21—19—17.

The three smallest specimens exhibit traces of dark green chevron-shaped markings like those of the juvenile specimens described below. The larger specimens (above 700 mm.) have lost all trace of such markings. In life they are uniform brilliant green in color, lighter on the belly, and with the prehensile tail dark green. On close examination, it may be noted that while the outer two-thirds of each scale is green, the base of the scale, hidden by the overlap of the one in front of it, is sky blue. When the scales are spread apart, the skin between them is seen to be bluish black.

One of the females was evidently gravid when received and gave birth to eight young on July 20, 1940. No observations on the birth process were made as the young were born and their first skins shed during the night. Seven were in good condition; one about half the size of the others, still enclosed within the egg membrane, and with a deformed spine, died the next day.

This brood includes four males and four females. The ventrals in the males range from 163 to 168, in the females from 156 to 164; caudals respectively 60-64 and 58-61. Excluding the imperfect specimen, which measured only 149 mm., the lengths of these specimens range from 243 to 269 mm.

In the juvenile specimens, the head exhibits a narrow dark line from the eye to the angle of the mouth. The body is uniform pale grayish-brown, darker above, and the back is crossed by numerous irregular narrow darker crossbands. Some of these form chevrons, most of them being interrupted at the mid-line. The tip of the tail is dark green or black. The juvenile coloration thus corresponds with that of *Trimeresurus nigroviridis nigroviridis.*

Half-grown mice were fed the adults, while the juvenile specimens preferred small *Anolis carolinensis.* Food was taken at night.—Emil J. Rokosky, *Reptile House, Chicago Zoological Park, Brookfield, Illinois.*

HYPSIGLENA OCHRORHYNCHA FROM KERN COUNTY, CALIFORNIA.—Two records of *Hypsiglena ochrorhyncha* from the southern end of San Joaquin Valley in Kern County, California, include one found 9 miles from Arvin, March 14, 1937, and one DOR found in the neighborhood of granite boulders near Woody on May 11, 1941. These specimens agree with the description given by Van Denburgh. Both have 193 ventrals; caudals in the Arvin specimen 49, 50 in the Woody specimen. The first specimen has single preoculars. The high ventral count may indicate a regional difference.—George H. Hanley, *Bakersfield, California.*

NOTES ON THE MATING OF DESERT RATTLESNAKES.—Fall mating of the horned rattlesnake, *Crotalus cerastes,* was observed on a recent field trip to Red Rock Canyon, Kern County, California, on the morning of September 20, 1941. A class of students from the University of California at Los Angeles, under the direction of Dr. R. B. Cowles, encountered a peculiar snake track, consisting of complicated superimposed markings in loose sand, which ended at a hole. There was no indication of the identity of the snakes but upon excavation of the hole a pair of horned rattlesnakes was found.

Analysis of the tracks showed the larger imprint of the male in places superimposed over that of the female. Mating activities were indicated by broadening and smudging of the tracks. It is not certain that copulation occurred.

The time at which the tracks were made was not earlier than 7:30 nor later than 8:00 A.M. A high wind that ceased at dawn would have obliterated the tracks made earlier in the morning. The air temperature at the time indicated was between 18° C. and 20° C. The snakes were found coiled in situ with ground temperature of 22° C. The minimum temperature during the night was approximately 14° C. Both snakes were brought to the University and placed in pits for further observation.

While looking for tracks of *Crotalus atrox* near Indio, Riverside County, California, on the morning of October 18, 1941, an area of fresh, confused, overlapping sidewinder tracks was found in front of the hole of a kangaroo rat colony. The tracks in this instance traversed an area approximately 4 feet square leading out of and into the hole. The track-area was unmistakably that resulting from mating activity. Two sidewinders, male and female, were dug out of the kangaroo rat hole where they were coiled side by side. No other tracks were to be found, fresh or old, leading to or from the track-area and hole. This fact indicates that the two snakes had been in the hole or vicinity since the previous morning, a period of twenty-four hours, and possibly much longer. The tracks were freshly made, placing the activity of the snakes between 6:00–7:00 A.M. and before 10:00 A.M., when the snakes were observed coiled near the entrance of the hole. Soil surface temperature in shade of hole (soil undisturbed), 28.5° C. Soil exposed to sun, 46° C.

On October 11, 1941, another pair of sidewinders collected near Indio, Coachella Valley, California, were found mating in one of the snake pits of the University. The snakes were entwined and carrying on courtship activities. At 12:30 P.M. copulation took place and continued until 2:30 P.M. at which time the female left the mating spot. During copulation the male's tail was wrapped around that of the female.

On October 8, 1941, following a successful collecting trip near Blythe, Palo Verde Valley (Colorado River), Riverside County, California, the opportunity was afforded to observe the courtship dance of *Crotalus atrox.* The specimens appear to have been collected at the peak of a fall mating season in a good sized colony.

Some of the freshly caught specimens of *atrox* were liberated in a large snake pit at Banning, California. A male nearly 4 feet long initiated most of the activity with a heavier female of the same length. The male began by crawling, with the typical caterpillar motion, toward the female lying several feet away. When he had approached within about 2 feet of the female, he raised the anterior third of his body vertically off of the ground. The female soon did the same. This stance, with the anterior third of the body raised and heads pointed almost directly at each other was maintained for a brief period. Next, the male made a forward movement, twined his neck about that of the female who then moved her head and neck in the opposite direction, so that the vertically raised portions of their bodies were intertwined. This "slow" twining of male and female contrasts with the "fast" twining of two male participants subsequently observed. After five or six seconds thus twined, both snakes fell to the floor where the remainder of their bodies (posterior two-thirds) entwined and the male vigorously wrapped his tail about that of the female. At this moment the female was disturbed by an observer, struggled violently to free herself from the male, and after doing so crawled quickly away to a corner. The performance observed was no doubt a preview of what takes place on a similar or more elaborate scale under natural conditions before actual union occurs.

Two days later, after the same group of snakes was liberated in one of the snake pits at the University, a similar dance occurred between two males 4½ feet long. This performance followed the same pattern as the courtship dance though minor variations

were noted. In no instance did any of the snakes attempt to bite. It is difficult to interpret the dance of the two males. A similar dance between two individuals of *Crotalus ruber* has been observed by Mr. James Deuel in San Diego County.—CHARLES H. LOWE, JR., *Department of Zoology, University of California at Los Angeles, California.*

FIELD NOTE ON THE COPULATION OF *CROTALUS ATROX* IN CALIFORNIA. —Taylor (1935, COPEIA: 154) has reported observations upon *Crotalus atrox* copulating near Tucson, Arizona, on August 19. From data including two other records, he suggests that "it is not improbable mating takes place at least from May to September" in that region. The present record for California is over a month earlier, preceding the dates assembled by Noble (1937, Bull. Amer. Mus. Nat. Hist., 73: 716) for several species of *Crotalus*.

On March 25, 1932, I accompanied the late Dr. Walter Mosauer on a trip to the Coachella Valley in order to assist him in locating sand dunes suitable for his research. Near Indian Wells, Riverside County, at 10 A.M. we crossed a wash to inspect a mesquite thicket. Fifty yards beyond the wash, in an area of small dunes, we discovered a rattlesnake track leading from a *Dipodomys* burrow. Following the track we observed that it was joined by a second track approximately 20 meters from the burrow. Looking ahead, where the track led nearly 5 meters farther, into a thinly foliaged patch of mesquite, we caught sight of a pair of western diamond rattlers already in copulation.

The male was coiled, roughly paralleling the round, flat, coil of the female. At intervals the male thrust his tongue upon the dorsal surface of the female, moving his head with quick, short jerks such as Taylor describes. The snakes were watched for about fifteen minutes, and the male continued his movements, the female remaining passive.

The rattlesnakes paid no attention to us until we attempted to place a noose on the male which then tried to crawl into the mesquite. The female was more aggressive and struck wildly in our direction, but we succeeded in noosing her and finally caught the male, whose left hemipenis was still partly inserted in the cloaca of the female. Shortly after capture the male was able to withdraw the hemipenis into his tail.

Observing their tracks more carefully now, it was possible to make the following deductions: One snake had emerged from a burrow and crawled about 20 meters, using the typical "caterpillar movement." Here in an open area, a second track leading from a burrow in a mesquite patch, hardly 5 meters from the junction of the two tracks, indicated that the second snake, probably the male, had crawled only this distance before meeting the first snake. Together the pair crawled side by side the remaining 5 meters into the thicket where we found them copulating. Imprints of the body, frequently superimposed, covering only 8 or 9 inches on either side of the pair when they were first observed, may have been made during the courtship "dance" described for other species of rattlers.

Baumann (1927, Ztschr. wiss. Biol., Abt. C, 10: 36–119) states that vipers (*Vipera aspis*) employ chemical cues in finding mates. No similar evidence has yet been available for crotalids. It would appear probable from the observations herein reported that chemoreception plays an important role in certain phases of the courtship of *Crotalus atrox*. On the other hand, it may have been fortuitous that each snake had crawled only a short distance before the pair met.—CHAS. M. BOGERT, *American Museum of Natural History, New York City.*

AN AGGREGATION OF SNAKES AND SALAMANDERS DURING HIBERNATION.—On January 3, 1939, just north of Mercer, Mercer County, Pennsylvania, the following snakes and salamanders were uncovered by workmen removing gravel from a bank and were brought to me by Mr. Erwin Frantz. The total length was measured after the specimens were preserved in formalin.

*Diadophis punctatus edwardsii* (Merrem)—1 specimen; 137 mm.
*Thamnophis sauritus sauritus* (Linnaeus)—1 specimen; 340 mm.
*Thamnophis sirtalis sirtalis* (Linnaeus)—4 specimens; 207 mm., 219 mm., 229 mm., and 231 mm.
*Storeria occipitomaculata* (Storer)—2 specimens; 174 mm. and 175 mm.
*Storeria dekayi* (Holbrook)—5 specimens; 151 mm., 155 mm., 165 mm., 260 mm., and 288 mm.

*Lampropeltis triangulum triangulum* (Lacépède)—1 specimen; 239 mm.

*Opheodrys vernalis vernalis* (Harlan)—2 specimens; 387 mm., and 499 mm.

*Triturus viridescens viridescens* Rafinesque—3 specimens in "red-eft" stage.

*Plethodon wehrlei* Fowler and Dunn—1 immature specimen.

A rattlesnake, about one foot in length, was also among this group, but it was separated from the other snakes and was killed and discarded by one of the employees. Since this locality is but 4 miles from Rattlesnake Swamp, from which specimens of *Sisturus catenatus catenatus* (Rafinesque) have been collected commonly, it probably was this species. No *Crotalus* have been taken from this county.

The 21 specimens were found embedded about 2½ feet from the surface, in soil that contained some gravel, from small pebbles to rocks averaging 2 to 3 inches in diameter. The snakes and salamanders were not massed in a compact group in a cavity but were found by sifting approximately 2 cubic feet of soil. A small partly decayed root nearly 2 inches in diameter which led from the surface of the ground to the hibernation area probably served as an entrance. No other specimens were found in the removal of additional gravel about the hibernating area. Freezing weather persisted for at least one month prior to January 3, and the specimens were dormant and motionless when received.

The topography of the neighboring land was of a gentle hilly nature, with small woodlands interrupted by pasture lands. The hibernation area was located on a small grassy hilltop with several scattered young trees, and woodlands were more distantly removed. This aggregation may appear to be abnormal, especially when considered in the light of the known hibernation habits of *Storeria* elsewhere. Perhaps these animals were surprised by an unseasonal cold spell and were forced into hibernation and therefore chose the nearest available place. A majority of the specimens were juveniles.

*Plethodon wehrlei* has been recorded in Pennsylvania from Clarion, Indiana and McKean counties. The single specimen (C.U.4132) among this group from Mercer County links the known areas of occurrence more closely.

These specimens have been placed in the Cornell University collection, Ithaca, New York. The writer wishes to thank Mr. Harold Trapido and Dr. Sherman C. Bishop for aid in identifying Wehrle's salamander.—Ernest A. Lachner, *Department of Zoology, Cornell University, Ithaca, New York.*

LIZARDS FROM THE GOAJIRA PENINSULA, COLOMBIA.—Forty-four specimens of lizards were obtained for the U. S. National Museum by Dr. Alexander Wetmore and Mr. M. A. Carriker, Jr., while collecting birds during the period April 19 to 26, 1942. I have been allowed to examine them through the kindness of Dr. Wetmore.

*Iguana iguana iguana* (Linnaeus).—Four specimens from Nazaret: Nos. 115063–6, taken on April 26, show a beautiful greenish-blue suffusion below and well developed nuchal tubercules above. They were infested with reddish wood ticks, some of which remain attached to the preserved lizards.

*Tropidodactylus onca* (O'Shaughnessy).—One, No. 115067, was secured at Maicao. It has a dark interorbital band; about seven irregular, transverse dark bands on back and more than 16 on tail (the distal ones weak); ground color whitish; subcaudal scales strongly keeled.

*Ameiva bifrontata divisa* (Fischer).—Thirty specimens: Nos. 115095, 115102 from Puerto Estrella; 115068–94 from Nazaret; 11506 from Puerto Lopez. These are interesting for the variation shown, including intergradation with or toward the eastern and insular subspecies *bifrontata*. No. 11506 and five of the 27 from Nazaret (20 per cent of the series) have three frontal plates (one behind the other) instead of the usual two. No. 115076 has a double row of granules along the inner border of the supraoculars instead of the usual single row. Eleven of the specimens are like typical *divisa* in having the supraocular granules continued forward to opposite the suture between the first and second supraoculars (36 per cent); one (No. 11506) has the granules extending only to the suture between the second and third supraoculars; and the rest (40 per cent) agree with *bifrontata* in having the posterior three supraoculars entirely surrounded by granules, which do not extend forward between the first supraocular and the median head plates. In none do the outer rows of ventral scales approach the large size of those of *concolor* of Peru.

*Cnemidophorus lemniscatus lemniscatus* (Linnaeus).—Nine from Puerto Estrella: Nos. 115096–115101, 115103–5.—Charles E. Burt, *Southwestern College, Winfield, Kansas.*

# Ichthyological Notes

RECORDS OF THREE SHARKS ON THE WASHINGTON COAST.—Three species of sharks not commonly recorded from the state were brought to light during a recent survey of the southern part of the Washington coast: the seven-gilled shark, *Notorynchus maculatus* Ayres; the great white shark, *Carcharodon carcharias* (Linnaeus); and the basking shark, *Cetorhinus maximus* (Gunner).

On May 18, 1942, an eviscerated female 8½ feet long (Fig. 1) of the seven-gilled shark was found on the beach at Grayland, Grays Harbor County. Outlines of several teeth are shown in Figure 2.

The great white, or man-eater shark is listed by Jordan, Evermann, and Clark (U. S. Bur. Fish., Rept. 1928 (1930): 20), and by Walford (Calif. Div. Fish, Game, Fish Bull. 45: 38), as occurring as far north as Monterey Bay. Schultz and DeLacy (Journ. Pan-Pac. Inst., 10.4: 1935), do not list it for the vicinity of Washington and Oregon. For present records of five specimens in Willapa Bay the writer is indebted to Elmer O. Pedersen of South Bend, Washington.

The first specimen (Fig. 7), 8 feet 2 inches long and weighing 342 pounds, was taken on August 28, 1936, in a gill net by Pedersen near the mouth of North River, and displayed as a man-eater at a South Bend fish market. Pedersen collected from the specimen the ten teeth illustrated in Figure 3 and removed a four-foot "green sturgeon," probably *Acipenser acutirostris* Ayres, from its stomach. The teeth were identified, and two were retained (U.S.N.M., No. 163016) by the U. S. National Museum as those of *Carcharodon carcharias*.

According to Pedersen, Ted Moore of South Bend obtained on or about September 1; 1936, in his gill net in the ship channel off Tokeland, a second specimen weighing 800 pounds, in whose stomach was a medium-sized harbor seal, *Phoca vitulina richardii* (Gray).

The third and largest great white shark, a male, was taken in a gill net about September 5, 1940, off Stony Point near Buoy 13 by Moore, who removed several teeth, four of which, although slightly damaged, are illustrated in Figure 4. The shark was 13 feet long and was estimated by Pedersen to weigh between 2,000 and 2,400 pounds.

Pedersen related that the fourth and fifth great white sharks were taken by gill nets on the same night in early August 1941, one by G. Ogren, weighing approximately 500 pounds, and the other by Ed Oblad, about 1,000 pounds.

On September 12, 1942, at Westport, Washington, dock attendants, fishermen, and Coast Guard personnel told of the landing approximately three weeks previously of a great white shark. Several teeth had been removed and saved by different individuals. One of the teeth, in the possession of a member of the Coast Guard Station at Westport, was located after a short search, and seen to be the characteristic triangular tooth of *Carcharodon carcharias*. It was nearly an inch wide at the base. Estimates from two or three individuals agreed fairly well that the shark was approximately 12 feet long and probably weighed between 800 and 1,000 pounds. Inquiries at later dates revealed no further details.

The basking shark, *Cetorhinus maximus*, although occurring in Washington, has not heretofore been commonly encountered (Chapman, COPEIA 1942:51). The remains of a male washed ashore about April 15, 1942, at the northern city limit of Long Beach, Pacific County. Residents said that the animal was cast up partially decomposed, without head or tail. State Fisheries Inspector M. E. Searela, Ilwaco, noted that the carcass was wrapped in a gill net when it first came ashore. Estimated length of the entire specimen was about 25 feet. Some teeth, gill rakers (Fig. 5), and the spurs (Fig. 6) of the claspers or myxopterygia were collected by Dr. V. B. Scheffer, May 11, 1942. The spurs measured 147 and 150 mm. in length, and corresponded to a figure of the spurs of this species by White (Bull. Amer. Mus. Nat. Hist., 74: pl. 46, fig. b).

On May 19, 1942, soldiers mentioned having seen a "whale" stranded at Grayland, Grays Harbor County, two weeks previously. They saved two "teeth" which proved to be the myxopterygial spurs of another male basking shark. One of the spurs is illustrated in Figure 7. An estimate of the length of the shark could not be obtained, but the length of the spur, 151 mm., suggests that the size was about like that of the other.

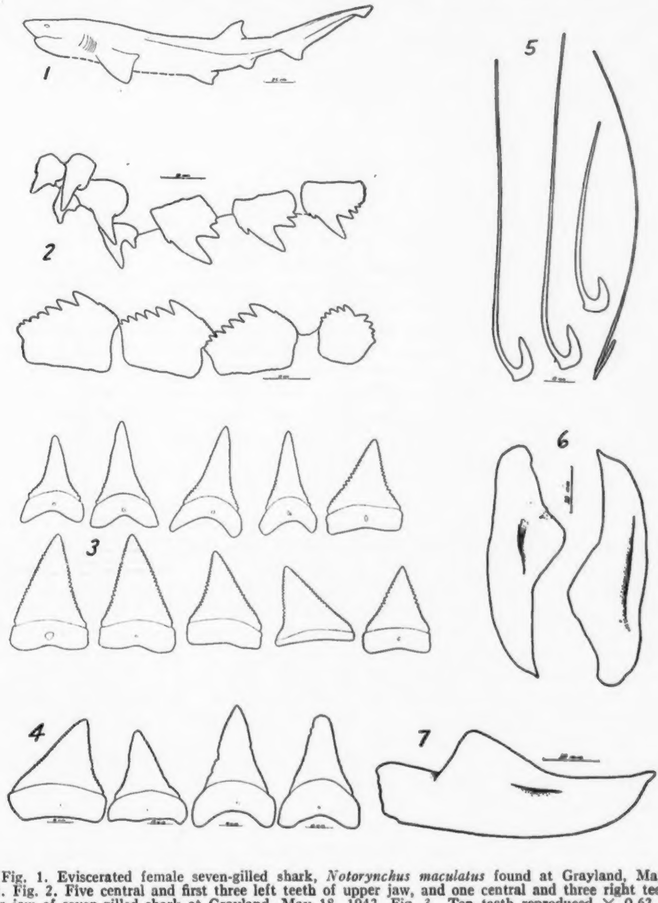


Fig. 1. Eviscerated female seven-gilled shark, *Notorynchus maculatus* found at Grayland, May 18, 1942. Fig. 2. Five central and first three left teeth of upper jaw, and one central and three right teeth of lower jaw of seven-gilled shark at Grayland, May 18, 1942. Fig. 3. Ten teeth reproduced × 0.62, from *Carcharodon carcharias*, taken at Willapa Bay, August 28, 1936. Fig. 4. Four teeth from great white shark taken at Willapa Bay, September 5, 1940. Fig. 5. Four gill-rakers of basking shark. *Cetorhinus maximus*, from Long Beach, May 11, 1942. Fig. 6. Myxopterygial spurs of basking shark from Long Beach May 11, 1942. Fig. 7. Myxopterygial spur of basking shark from Grayland, about May 5, 1942.

On June 14, 1942, 0.4 miles north of Klipsan Light between Ocean Park and Long Beach, Pacific County, there were seen the 12½ foot remains of another basking shark. Only the protruding ends of the vertebral column and a central mass of decomposing flesh around the vertebral column were present, so that the sex could not be distinguished. Identification of species was based upon the appearance of the vertebrae and the large size of the carcass.

Mr. H. G. MacDonald, operator of a fish-reduction plant at Anacortes, in conversation with Scheffer, stated that approximately twelve sharks, locally called "sleepers," one over 30 feet long, and all with gill slits running the depth of the animal, had been brought to his plant. These could have been only basking sharks. The species is evidently more common than was formerly supposed.

The stranding of the basking sharks and the seven-gilled shark occurred within a period of a few weeks, at a time when offshore storms or a concurrent outbreak of "mussel poisoning" could have contributed to their death. During the same period there were found dead on the Washington coast other fishes, hundreds of sea-birds, and at least six porpoises.—KELSHAW BONHAM, *State of Washington Department of Fisheries, Seattle, Washington.*

*SELAR* EQUALS *ATULE,* A SUBGENUS OF *CARANX.*—In the family Carangidae a great number of species, showing a wide variation of form, center around the genus *Caranx.* These are the Caranginae, a group in which I have been much interested. However different one from the other, they all seem to be closely related; their differences are often bridged by intermediates, and most have been considered members of the old comprehensive genus *Caranx.* However, there are certain tangible subgroups which should be and customarily are recognized as distinct genera, such as the aberrant *Selene, Vomer* and *Alectis; Trachurus, Decapterus* and *Trachurops,* each with its structural peculiarity; *Carangoides,* a genus of convenience, dividing the many species which would otherwise remain in *Caranx,* more or less on the basis of evolutionary level. There are also groups, sometimes recognized as genera, which make more or less satisfactory subgenera. One of these is (*Selar*) Bleeker equals (*Atule*) Jordan and Jordan, type *Selar hasseltii* Bleeker (Jordan, 1919, Genera of Fishes, 2: 248) equals *Caranx affinis* Rüppell and *Caranx mate* Cuvier and Valenciennes. The subgenus (*Selar*) seems to be a natural group for the convergent bases of two or more phyla. Not many species are involved.

Bleeker, 1851 (Nat. Tijd. Ned. Ind., I: 352, 353, 359–362), describing East Indian fishes, proposed a genus *Selar;* mentioned 3 species in the literature which he referred to it, *plumieri* Cuvier and Valenciennes from the West Indies (which is a *Trachurops*), *analis* Cuvier and Valenciennes from St. Helena (which is a *Caranx* not of the subgenus *Selar* as here understood), *djeddaba* Rüppell from the Red Sea; this last of the same group as the five East Indian species he describes, namely, *Selar macrurus, hasseltii, kuhlii, brevis,* and *malam* (all of the subgenus *Selar* as here understood). He mentions no other species.

Jordan and Gilbert, 1884 (Proc. U. S. Nat. Mus., VI: 192) give "*boops,* etc." as type of *Selar,* citing a slightly later publication by Bleeker in a different journal; and American authors in general followed this designation of the type as *boops,* though using the name for the group represented by Bleeker's five original species, of which another species occurs on the American Pacific coast. Jordan, 1919 (*l.c.*), designated Bleeker's *hasseltii* as the type of *Selar,* on the ground that *boops* was invalid, not having been in the original description. I have examined his evidence, agree with his conclusion, and concur in that designation.

However, Jordan and Jordan, 1922 (Mem. Carn. Mus., 10: 38), finding that *boops* is a *Trachurops* (which it is), accept it as the type of *Selar,* make *Trachurops* Gill, long current, a synonym thereof, and propose *Atule* for the subgenus (*Selar*) as here understood, type *Caranx affinis* Rüppell equals *Selar hasseltii* Bleeker. They have been followed by various recent authors.

To use *Atule* in place of *Selar* for the subgenus of *Caranx* should cause no ichthyological confusion, and one is tempted to do so. To use *Selar* (the type of which may be questioned, though in light of evidence to hand it is plain enough) in place of *Trachurops* for the genus, may cause a great deal. Wakiya, 1924 (Ann. Carn. Mus., 15: 159, 198), does both without confusing the relationship of the groups. Weber and de Beaufort, 1931 (Fishes Indo-Austral. Archipel., 6: 205–220), on the other hand, mix species of the two groups under *Selar,* ignoring what has been learned of their relationship since Bleeker's time, though their closeness seems only that of having been caught in the same nomenclatural tangle.—J. T. NICHOLS, *American Museum, New York, New York.*

ON THE BEHAVIOR OF YOUNG *OLIGOPLITES SAURUS* (BLOCH AND SCHNEIDER).—Young specimens of *Oligoplites saurus* (Bloch and Schneider) appear on the west coast of Florida during June and July in the waters sheltered by the numerous islands in Pine Island Sound. The following observations concerning their behavior were made from the dock of the New York Aquarium laboratory on Palmetto Key.

Specimens of from 27 to 34 mm. in standard length are not infrequently to be seen drifting passively in the tidal flows at that place. They rest near the surface of the water, generally head-down or twisted in such a manner as to somewhat resemble a half water-logged leaf and present a most un-fish-like appearance. Generally they are solitary or, at most, in widely spaced groups of not more than three. In the water they seem to have the color of a yellowish leaf, but on close inspection are seen to be of a brassy silver or greenish brassy sheen. They drift motionless and allow a very close approach but are alert and quite able to dart off suddenly and can easily avoid a dip net. Perhaps the simplest way to catch them is to allow the tidal flow to carry them into a stationary dip net. This is usually permitted by the fish.

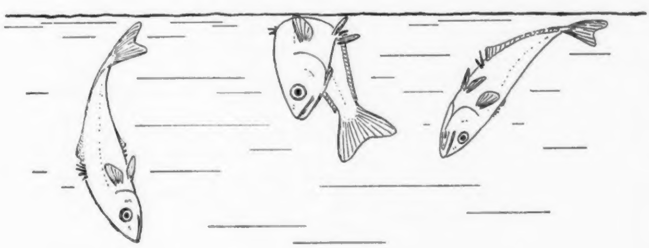


Fig. 1. Young *Oligoplites saurus* drifting leaf-like at the surface. Semi-diagrammatic sketch from life.

Characteristic poses are shown in Figure 1, which was sketched from life. Actually when seen in the water none of the fish-like details may be noted and the effect is quite unlike that of the drawing. If three dead leaves had been sketched they would have made a better representation. Photography was found to be impracticable for once disturbed they were not seen to resume their floating posture.

Although there is no other physical evidence that could be noted these fish are evidently lighter than the water in which found as they float at the surface without evident muscular effort.

Three specimens were placed in a small aquarium which happened to contain a school of about a dozen *Harengula macropthalma* (Ranzani) of similar size. Within a few hours they had become as silvery as the herrings and in a general way looked somewhat like them. The transfer to the aquarium had evidently broken their curious leaf-like drifting habit, which, as above noted, is readily disrupted. They swam about actively in an ordinary carangin fashion and made some irregular desultory attempts at schooling with the *Harengula,* but for the most part kept to themselves as a loose aggregation, never as a compact group.

Larger specimens, mature in character, are relatively common in this vicinity. The juvenile characters of the specimens studied are indicated in the sketch. While readily recognizable as *Oligoplites,* the tail and pectorals are shorter and more rounded, and the dorsal and anal spines longer than in the larger sizes. The premaxillaries are still somewhat protractile at this size.—C. M. Breder, Jr., *New York Zoological Society, New York.*

# Reviews and Comments

HANDBOOK OF FROGS AND TOADS. By Anna Allen and Albert Hazen Wright. Comstock Publishing Co., Ithaca, New York: XI + 286 pp., 88 pls. $3.00.—I have long had a sentimental regard for Ithaca. My uncle, Edward LeBreton Gardner, taught mathematics there, was a great friend of Louis Fuertes' father, a famous rowing coach and, I believe, finally President of the Cornell Alumni. I should know much more about the place than I do. I did, however, visit the town once several years ago, motoring with my brother-in-law. I went specifically to call on Doctor and Mrs. Wright at their home, to be enchanted by their lovely collection of photographs and their most agreeable and friendly hospitality.

Now, just the other day, the new edition of their *Handbook of Frogs and Toads* came to hand, quite the best little publication of its sort which I have ever seen. Designed primarily for "teachers, students and even younger naturalists" it has just as strong an appeal to an old pod like myself and I have learned much from its perusal.

The Wrights acknowledge the limitation of their own information and their little queries which frequently close the notes regarding the different species are suggestive, pertinent, and well chosen. In other words this little book tells us what we know and also outlines for the benefit of the students of the future many problems which are still to be solved. The photos are in almost every case excellent and adequate; the ranges concisely set forth; the notes on habitat informative and the descriptions clear cut and not too long winded.

My friends know that I do not sleep much at night, a good deal of the time, and when I picked this little book up at 2 o'clock this morning, having taken it home (for it only arrived yesterday), I thumbed it through page by page most enjoyably until dawn brought with it the presumption that I should like to write this short review.—T. Barbour, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

BYWAYS TO ADVENTURE. By Edwin Way Teale. Dodd, Mead and Co., New York, 1942. X + 222 pp., $2.75.—The fact that amateur natural history observation may be developed into the most absorbing of avocations, and may thus add the extraordinary rewards and satisfactions of productive scholarship to the career of the humblest citizen, is far from being widely known. Mr. Teale's book serves as a most excellent guide to the possibilities of natural history for hobbies. By means of rather voluminous bibliographies, following each chapter, it may serve the still more important purpose of opening up the serious study of the subjects included in its list of chapter headings. The subjects thus dealt with are bird watching; observation of the weather; astronomy; entomology; conchology; herpetology; botany; microscopy; mineralogy; studies of living mammals; paleontology; limnology; conservation; and nature photography. The final chapter is a list of museums, useful in spite of its equally erra[illegible]ns of inclusion and omissions, since Museum staff members form one of the best links between the amateur and the professional level of interest in natural history. The reviewer would like to see this book in the hands of every high school science teacher in the country, and its book lists form an excellent guide to librarians, both in schools and in the smaller public libraries, which so often fail to appreciate their opportunities to aid the more serious minded of their readers in the self-education that may often have more far reaching and perhaps more deep reaching results than any formal education.—Karl P. Schmidt, *Field Museum of Natural History, Chicago, Illinois.*

COLLEGE AND UNIVERSITY MUSEUMS, A MESSAGE FOR COLLEGE AND UNIVERSITY PRESIDENTS. By Lawrence Vail Coleman. American Association of Museums, Washington, D. C. 1942: 1-viii, 1-65, several figs.—This is a report addressed to presidents and trustees of American colleges and universities, on the present status, utilization, and desiderata of Museums of Art and Science in institutions of higher learning. It is to be hoped that the numerous addressees receive and read their respective copies of this book. They cannot fail to be stimulated to an interest in its subject.—L. A. Walford, *Stanford University, California.*

HISTORIA NATURAL DO BRASIL. By Jorge Marcgrave. Translated by José Procopio de Magalhaes. Edited by Affonso de E. Taunay and a staff of specialists. Folio, iv + xii + 300 + civ pp. (Being a Portuguese translation of the HISTORIAE RERUM NATURALIUM BRASILIAE of Georg Marcgrav of Liebstad, published at Leiden and Amsterdam in 1648, and preserving the original format, illustrations, pagination, and, to a large extent, typography as well, with 104 pages of commentaries by a staff of distinguished Brazilian historians and naturalists.). Sao Paulo, Brasil; Imprensa Oficial do Estado. 1942. Price in paper covers, 100 milreis (= $5.24).—Within the last decade or so, Brazil has become acutely aware of the richness of her national patrimony, not only in natural resources, but also in the wealth of historical, geographical, ethnological and biological information published by the many voyagers who have travelled or studied in the country. Great numbers of these works, both early and recent, have been and are being translated partially, or more often, completely into Portuguese. The bookshops of Rio overflow with well done translations of the books of Maximilian of Wied, Spix and Martius, Agassiz, Hartt, St. Hilaire, Wallace and many others, not to mention new editions of the older Portuguese works and numerous new books on many phases of history and biology. Fortunately for thin Brazilian pocketbooks, most of them are published in cheap editions, but these usually transmit but little feeling for the grandeur of many of the original editions.

The present work is of a different type. The editors have selected the earliest and most famous work on the natural history of Brazil, and, having translated it, have brought it forth in a form so like its splendid original that the reader has the distinct feeling of having the 1648 edition in his hand. All of Marcgrav's inimitable illustrations, perfectly reproduced, are present, and in the same position on the same pages as they are in the original. Even the type used is remarkably similar to the old seventeenth century Dutch type. The unforgettable title engraving, and the secondary title page and dedication, are reproduced exactly. The paper used is in keeping with the general excellence of the typography.

Georg Marcgrav was, so far as the reviewer is aware, the first naturalist to publish descriptions and figures of fishes sufficiently accurate to be identified specifically. Many are inaccurate and some comically grotesque, but he usually put sufficient character into his fish sketches to make them recognizable, and a number of the Brazilian fishes he figured were later introduced into Linnaean nomenclature on the basis of his work. It is therefore unfortunate that the two excellent authors (Dr. Paiva Carvalho and Dr. Paulo Sawaya) of the ten closely printed folio pages of ichthyological annotations[1] were limited in their library facilities. They have placed most of the species correctly by reference to Cuvier and Valenciennes, who frequently quoted Marcgrav, but a few errors have crept in. For example, the "Guaperua" (p. 145) is certainly a young *Selene*, not a pediculate; the "Tareira d'Alto" (p. 157) is *Synodus* (a marine fish, as Marcgrav says it is), not a fresh-water characin; and the "Guarerua" (p. 178) is a young *Pomacanthus*, not a pomacentrid. The biographical account of Marcgrav, by Dr. Taunay, is excellent, and makes full use of Dr. Gudger's biographical paper of 1912.

Libraries and individuals who have despaired of locating (or paying for) an original Marcgrav will find the translation an excellent substitute. Moreover, be they naturalists or bibliophiles, the book will please them. Those unfortunates who are both will find it absolutely necessary.[2]—GEORGE S. MYERS, *Museu Nacional, Rio de Janeiro, Brrazil.*

REPRESENTATIVE NORTH AMERICAN FRESH-WATER FISHES. By John T. Nichols, illustrated by Andrew R. Janson. The MacMillan Co., New York, 1942: 125 pp., several figs. $1.25.—Mr. Nichol's latest book is intended to serve both as a layman's introduction to ichthyology, and as a handbook for identifying the commoner North American fresh water fishes. The discussion on each species is limited to a single page of brief description, pertinent comments on the relationship, life history, etc. Each species is illustrated with a full page sketch, sometimes in color. The list of fishes described is far from complete, there are no keys, and the arrangement of fishes is without any apparent order (a fault of book making, I suspect). Nevertheless, amateurs, for whose sole use

[1] Also separately printed as a brochure.

[2] Copies beautifully bound in half or full morocco are on sale in Sao Paulo and Rio bookshops at 200 to 250 milreis. Two original copies of Marcgrav are for sale in Sao Paulo at four contos each (= $210).

the book is intended, will find it useful for their purposes; for it is simply, though authoritatively written, is of handy size for pocket-carrying, and is inexpensive.—L. A. WALFORD, *Stanford University, California.*

WILDLIFE CONSERVATION. By Ira N. Gabrielson. Macmillan & Co., New York, 1941: i–xv, 1–246, 24 figs., 32 plates. $3.50.—Working in the specialized field of fishery research, one easily becomes completely absorbed in the complexity of activities occasioned by his "problem." For him, then, *Wildlife Conservation* will reestablish perspective. For layreaders, it is an informative, well written work on conservation in general. Mr. Gabrielson considers that three concepts form the basis of the conservation "movement": (1) "that soil, water, forest, and wildlife conservation are only parts of one inseparable program; (2) that wildlife must have an environment suited to its needs if it is to survive; and (3) that any use that is made of the resource must be limited to not more than the annual increase if the essential seed stock is to be continually available." That is the central thesis, which is demonstrated amply in a review of the Nation's natural resources. In spite of the educational character of the subject, this is no stuffy book; it is engagingly written and well illustrated.—L. A. WALFORD, *Stanford University, California.*

THE SEASHORE PARADE. By Muriel Lewin Guberlet. The Jaques Cattell Press, Lancaster, Pennsylvania, 1942: 1–197, several figs. $1.75.—This book for children about life at the seashore is a mixture of whimsy and fact. These ingredients are not skillfully blended, so that there are passages written in the wee style, interspersed with other passages of school text material. The result is rather indigestible for children, and not very interesting.—L. A. WALFORD, *Stanford University, California.*

BILL, THE BROADBILL SWORDFISH. By S. Kipp Farrington, Jr. Illustrated by Lynn Bogue Hunt. Coward McCann, Inc., New York, 1942. $1.50—In contrast to the preceding work this one, also written for children, is truly successful. It has the prime virtue, necessary for children's books, of being consistently simple and never condescending. Though it is at all times amusing, it is informative, too. The illustrations and format are charming.—L. A. WALFORD, *Stanford University, California.*

**Editorial Notes**

FINANCIAL aid in publishing the October issue of COPEIA was received from the DEPARTMENTS OF ZOOLOGY AND ENTOMOLOGY, CORNELL UNIVERSITY.

The Society is proud of its many members in the service of our country, and to them extends sincere wishes for a happier New Year.

# INDEX TO SCIENTIFIC NAMES
## 1942, Nos. 1-4

New names and their principal references are printed in bold face type.

# COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS



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ΙΧΘΥΣ
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